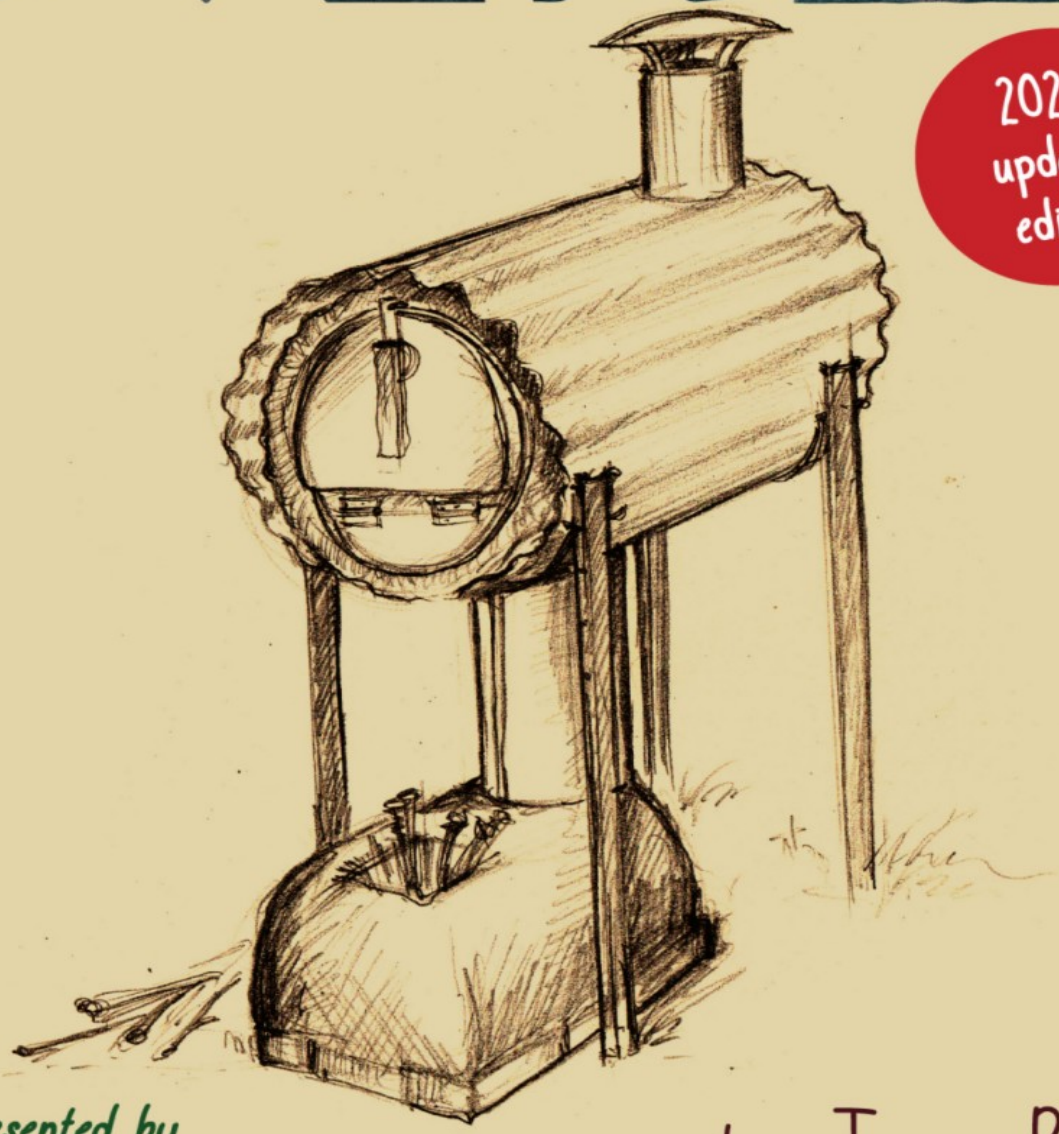
THE ROCKET POWERED OVEN

how to build your own super-efficent cooker

2020 updated edition



presented by

Very Edible Gardens™
APP-TECH workshops

words: Tim Barker

illustrations: Joel Meadows

The Rocket Powered Oven

How to build your own super-efficient cooker

By Tim Barker

Illustrations by Joel Meadows

First published in 2016 by Very Edible Gardens PTY LTD (Australia).
Second edition 2020.

Text © Tim Barker

Illustrations © Joel Meadows

This book is copyright. Apart from fair dealing for the purposes of private study, research, criticism or review, as permitted under the Copyright Act, no part may be reproduced by any process without written permission from the author. Enquiries should be addressed to the author. You can contact the publishers and both Tim and Joel via the form at www.appropriatetechnology.com.au.

Table of Contents

About this volume
Foreword: the future of fire
Introduction
Fire
Conventional stoves
Rocket stoves
The anatomy of a rocket stove
How a rocket stove works
Dimensions
Materials
Ingredients
Rocket stove power unit
Black oven
White oven
Building your rocket stove ‘power unit’
The mock up
Starting the stove
Final placement
The final build
Building a black oven
The baffle plate
Building a white oven
Barrel safety
How the white oven works
Making the inner barrel
Making the outer barrel
Closing up the outer barrel
The shelves
The door
Building the door latch
The stand
Insulating and covering the oven
Final touches
Controlling the beast, or how to cook with your oven

Taking care of your beast
Tips and tricks
Learn more!
VEG appropriate technology workshops

About this volume

In this booklet Tim and Joel take you through a step-by-step guide to building an extremely cheap, rocket stove powered oven using easy to access materials such as bricks, clay and reclaimed steel barrels. These designs may not quite have the domed top elegance that has made the backyard cob pizza oven so trendy, but they do have a farm yard charm of their own. And rather than taking hours to heat up to cook a couple of pizzas (and subsequently only used once a year!), these are super efficient, and very practical stoves. Both Tim and Joel use theirs on a daily basis. Their potential as a genuinely sustainable backyard fixture of the future is very high.

In the first section you'll learn about the fascinating principles of the rocket stove, and in subsequent sections they will get down to the detailed business of building them. To complete the projects yourself, you'll need a handful of common tools, and a little confidence using them, but the process will demand nothing beyond the scope of the most casual backyard tinkerer. The focus of this volume is on cooking, and we'll be presenting two options for DIY ovens, appropriate for both outdoor and – if correctly flued and sited – indoor use. The foundational section on the rocket stove base, will also serve you well for other rocket stove applications, namely hot water systems and home heating – two topics we're hoping to cover in complementary booklets in the not too distant future. Stay tuned for these (and upcoming workshops) at: www.appropriatetechnology.com.au

Foreword: the future of fire

Adam Grubb

Around a million years ago our ancestors learned to control fire. So significant was this moment, that by the time we evolved into Homo sapiens some 350,000 years ago, our whole digestive system had come to expect its food cooked, and our lungs had adaptations to cope with air pollution.

It's somewhat humbling therefore to learn that for those last one million years – and let's be frank here – we've been *doing it wrong*.

Three billion people continue to cook on biomass each day. The smoke caused by this (despite our genetic adaptations) is a major health issue, and the excessive use of fuel is a major environmental one. Smoke however, is nothing but unburnt fuel, and more efficient combustion offers both more heat, and an end to the cancer and coughing.

Enter the rocket stove. First conceived by Dr. Larry Winiarski in 1982, the rocket stove is so subtly simple a technology that it could have been around for all one million of those smoky years. Talk about missed opportunity. But at least it is known now. In retrospect it's an almost obvious concept: burn the fuel first and fully, and then, and only after *complete combustion*, extract the heat. At the crudest end of the spectrum, you can build them with nothing more than a few bricks and some mud. It's perhaps this simplicity – it's not a Tesla sports car after all – that explains why the Wikipedia 'rocket stoves' entry at the time of writing sits at a measly 150 words. But trust us, this may be a much more revolutionary technology than any over-hyped sports car.

No one I've met has as much enthusiasm, knowledge, and hands on experience in rocket stoves as Tim Barker. Tim is a perennially ash and grease-stained appropriate technology tinkerer with a professional mechanic background, combined with years of experience in permaculture. He also

admits to having something of a pyromaniac tendency. He probably would have made a fine supervillain but thankfully he’s harnessing his powers for good. You’re helping keep him on the narrow path by downloading this booklet. Seriously, with a dearth of good, cheap, accessible information about rocket stoves, a better person could not be found to produce this booklet. Our illustrator, Joel Meadows, is a himself an appropriate technologist, craftsperson, metal worker and permaculture practitioner *par excellence*. When Tim and Joel get together the ideas flow and sparks always soon fly. Figuratively and literally. They are always pushing themselves, always learning, and we’re extremely proud to have them together in this much needed publication that can help you avoid the pitfalls, and make a great rocket stove powered oven to call your own.

Adam Grubb is Co-director (with Dan Palmer) of Very Edible Gardens PTY LTD in Melbourne, Australia, and co-author of The Weed Forager's Handbook and The Art of Frugal Hedonism.

Introduction

For a long time I've thought that more information was needed for the construction of rocket stoves that could be used on a day to day basis. Typically, most people constructing rocket stoves have done so using materials and methods that practically guarantee they will either fall apart or simply become novelty items in a very short time. While it is certainly important to experiment (vital, even) once you have reached a good level of 'hands on' understanding, then I believe it's important to start working on applications that have utility of use, that is – they are practical and reasonably convenient to use, durable and where possible, use everyday materials.

A lot hinges on the word 'convenient'. Compared to a gas or electric stove, any wood burning stove is simply not as convenient. It's my personal belief that one of the great stumbling blocks for realising a better world is that it will mean a certain loss of convenience in most of the day-to-day tasks we perform. However, with convenience comes a loss of connection, of mastery, of art in our lives.

Don't get me wrong – a certain amount of convenience is a good and desirable thing. It's when it disconnects us from the processes that sustain our lives that we run off the rails. I often hear stories of memories of mothers or grandmothers bustling about a kitchen invariably in an apron, hands dusted with flour, a little perspiration beading their upper lip as they expertly tend a wood stove. Invariably, these are good memories.

The incredible aroma of freshly baked bread or of a roast seasoned with a hint of wood smoke in the air has a mystic quality, the combination of those two most universal of human obsessions, the fascination with food and fire, speak to us in a language embedded in our very genes.

The one thing I always take with a grain of salt is the stories of those same mothers and grandmothers fighting to keep their stoves once a gas or electric alternative became available. If we look at it from their perspective,

it must have been a revelation to simply set a temperature and be able to do something else until the food was ready to be served.

Not to mention the removal of the need to collect and chop wood. However, I believe those same mothers and grandmothers would have fought tooth and nail to keep their wood stoves if they had realised that this was simply the first step in a process that would give us microwave TV dinners and instant cake mixes.

The ovens and ideas I present in the following pages will, I hope, strike a balance between the convenience of our more modern stoves and the less convenient, but so much more soul nourishing stoves of yesteryear.

•

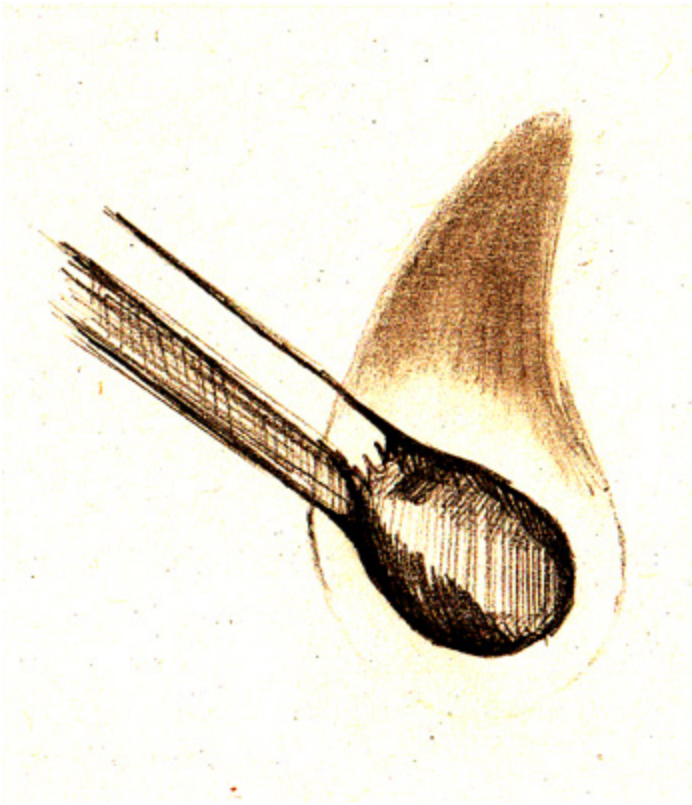
There is currently a huge fascination with a combustion technology known as the rocket stove and for very good reason. The rocket stove has some very desirable traits:

- It offers complete combustion of the wood
- It can reach very high temperatures
- It can use wood typically considered too small to bother with
- It is easily built from common materials

If we combine all these features, what we find ourselves with is a cheap, easily built stove that is incredibly frugal on wood and clean burning. The main thrust of this booklet is how to build two different types of ovens for using the resultant heat to produce healthy, delicious food.

Fire

But first comes fire and a little experiment. If we get a match and light it and hold it level and look closely at the flame, we will see something that may appear odd. There is a gap all around the match where there is no flame.



The flame never actually seems to touch the match, but springs up around it. Now we are all so familiar with fire that we don’t often think about what it actually is. “It’s just fire!” we say.

Fire is a chemical reaction and with the chemical reaction that is wood combustion, three things or conditions need to be present for it to happen:

- Firstly, we need a source of fuel, this is of course the wood.
- Secondly, a heat source. This could be a spark, a magnifying glass, friction, lightning or even another chemical reaction (the red head on the match).
- Thirdly, we need oxygen to support combustion.

It is a self-sustaining reaction. As long as we keep fuel up to the fire, don’t restrict oxygen and don’t cool it below the reaction temperature, it will continue to burn.

These three elements form what is commonly called the fire triangle. Remove any of them and you don’t have combustion – a fact often

exploited by fire fighters.

The fire triangle

Specifically, what happens when we burn wood is we break down the chemical bonds in the cellulose that makes up the greater mass of the wood. This breakdown of the cellulose releases volatile gases, in other words, smoke. This smoke then combines with the third of our requirements for combustion: oxygen in the air – and if the temperature is high enough, it combusts.

The final part of the process is when all the volatile gases have been driven off and burnt. We are left with the char or charcoal, which in turn, combined with heat and oxygen, burns down into ash which is the non-combustible materials (minerals etc.) left behind.

From this we can infer a couple of things:

- Firstly, smoke is fuel. So if we see smoke, we are wasting fuel.

- Secondly, wood combustion is a two step process. First we burn the smoke, then we burn the charcoal.

So, back to our burning match. We now know what we are seeing is the smoke being driven off from the wood and burning and finally when all the smoke is combusted, the char at the end of the process is left behind. The char doesn’t burn because the fire is so small that the temperature gets below its combustion temperature.

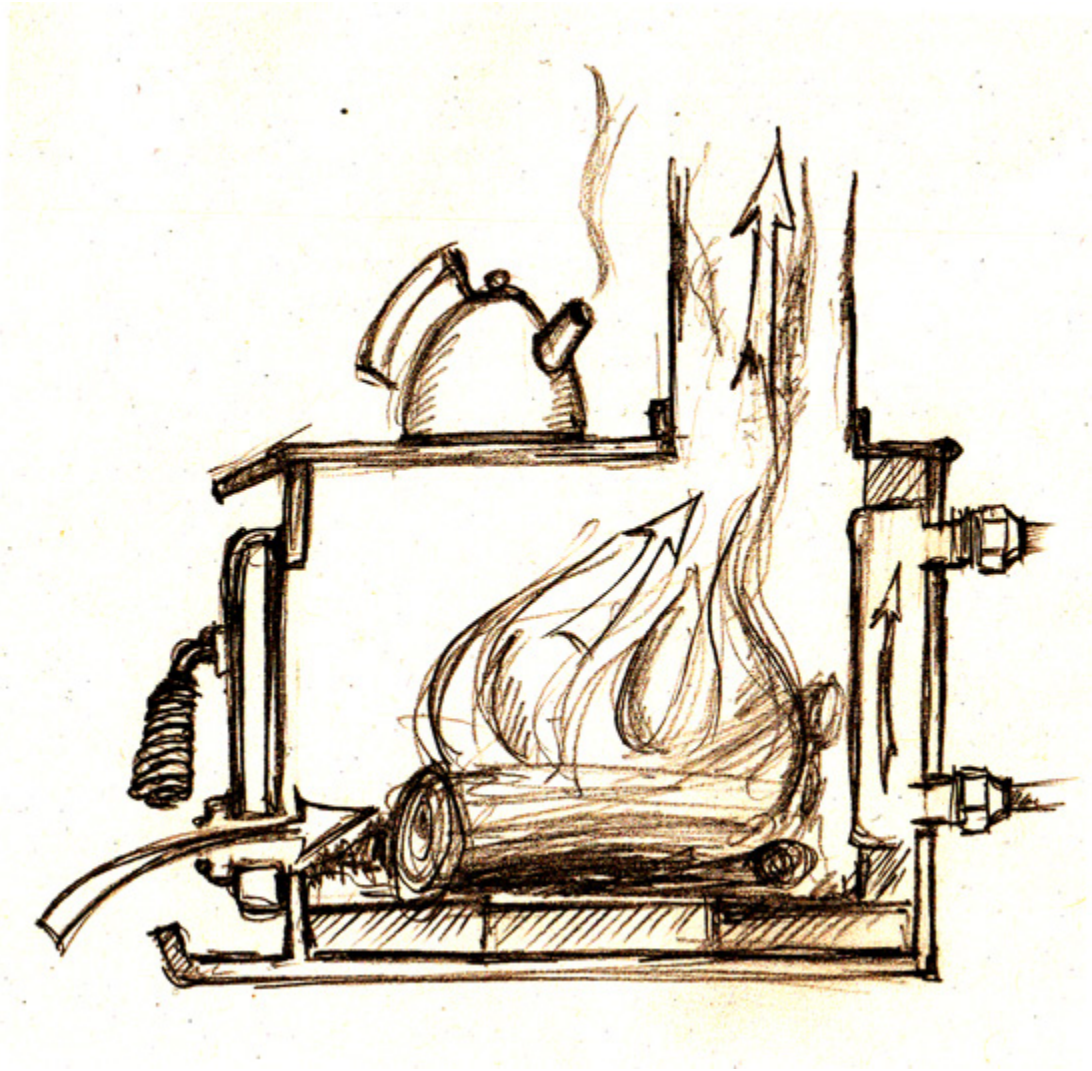
Conventional stoves

Before we look at rocket stoves it will be instructive to look at a conventional wood oven so we can compare apples with apples.

A conventional or ‘box’ oven is simply that, a big steel box. Often the sides and bottom will be lined with some material, usually fire bricks, which will make the interior much more durable as generally steel doesn’t do well in the environment inside an oven.

There will be an air inlet low and to the front and a chimney flue at the rear. Wood is piled in the box on top of some kindling and paper and the fire lit. The fire then heats the top of the box and food is cooked on the outside surface (hot-plate). The remaining hot gases then flow up and out the flue

Often too there will be an arrangement of water filled metal tubing in the rear or side of the box that leads off to a storage tank for domestic hot water. In Australia and New Zealand this is commonly called a wetback.



Cross section of a conventional box stove with a ‘wetback’

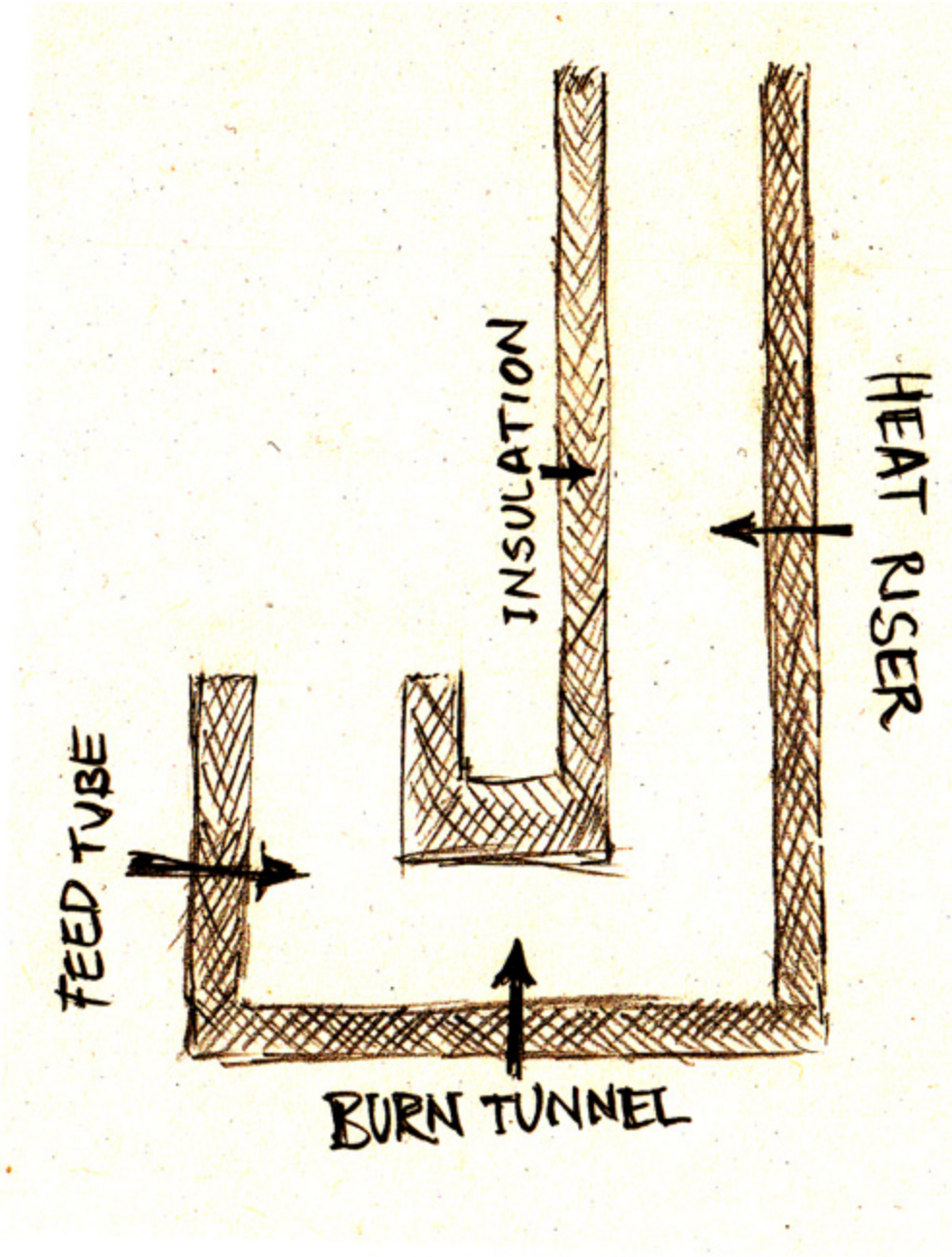
Rocket stoves

At its most basic, a rocket stove is simply a ‘J’ shaped tube. We light a fire in one end and hot gases come out the other. There are a number of fundamental differences between a rocket stove and a box stove.

1. Rocket stoves are very well insulated, by trapping the heat inside the stove we insure we are burning virtually all the fuel. Remember that smoke is unburnt fuel. Except when starting a well tended and built rocket stove WILL NOT SMOKE and will not build up creosotes, a sticky tarry substance that is basically unburnt combustion products. Box stoves are not well insulated so they don’t reach the temperatures to ‘crack’ all the combustion products.
2. No heat is extracted from a rocket stove till the combustion process is finished so again this means we maintain higher temperatures inside the stove for complete combustion. In a box stove we extract heat AS the fuel combusts not after. The cook top is the top of the stove so it is bleeding heat out of the combustion chamber as the fire burns. If the stove also has a wetback then we are extracting even more heat. The result is much lower combustion temperatures and hence inefficient combustion.
3. In a rocket stove the fuel ALWAYS sits behind the flame so any smoke from the fuel must pass through the flame. This insures complete combustion. In a box stove the fuel sits above the flame so often any smoke is driven off after the flame resulting in incomplete combustion.

All of these factors combined virtually guarantee poor combustion in conventional box stoves. Now this is not to say conventional stoves can’t be made to approach the efficiency of a rocket stove, they can but the cost of manufacture and the complexity compared to a rocket stove are huge.

The anatomy of a rocket stove



The feed tube

The feed tube performs a number of functions. Firstly, it has to be tall enough that our sticks don’t topple over sideways but no taller than this for reasons we will discuss shortly.

Secondly, it is the air inlet to the stove. All air enters here so it must be correctly sized.

Thirdly, this is the area of the stove that will receive the most physical abuse as it is here we load our sticks in and clean the ash out so its construction must be solid enough to resist this.

The burn tunnel

This may seem obvious, but the burn tunnel is where most of the combustion occurs.

The burn tunnel should have the same cross sectional dimensions as the feed tube. In fact we try to maintain the same cross sectional area throughout the stove where possible.

The burn tunnel should be as short as practical.

The heat riser

Again fairly self explanatory but the heat riser is where our hot combustion gases begin to rise as they turn the corner of the burn tunnel. Final combustion is also accomplished here.

Insulation

Insulation is simply a material that stops or slows the transfer of heat. A fundamental reason for a rocket stoves efficiency is that it is very well insulated and so traps the heat from combustion inside the stove.

How a rocket stove works

By its very nature a rocket stove uses sticks rather than logs. That doesn’t mean you can’t use logs, it’s just that you will split them first. Now the size of the stick will depend on the size of the stove. The size of the stove we will be discussing is between 150mm and 180mm. This is the diameter of the opening for the feed tube and, as previously mentioned, will be the diameter we try to maintain throughout the stove. In this system sticks up to 60mm in diameter can be burnt. As for length that will depend entirely on

factors such as how straight the sticks are and how long they can be without jamming or catching on the walls of the feed tube. Typically sticks 500mm long will be fine but your results will vary.

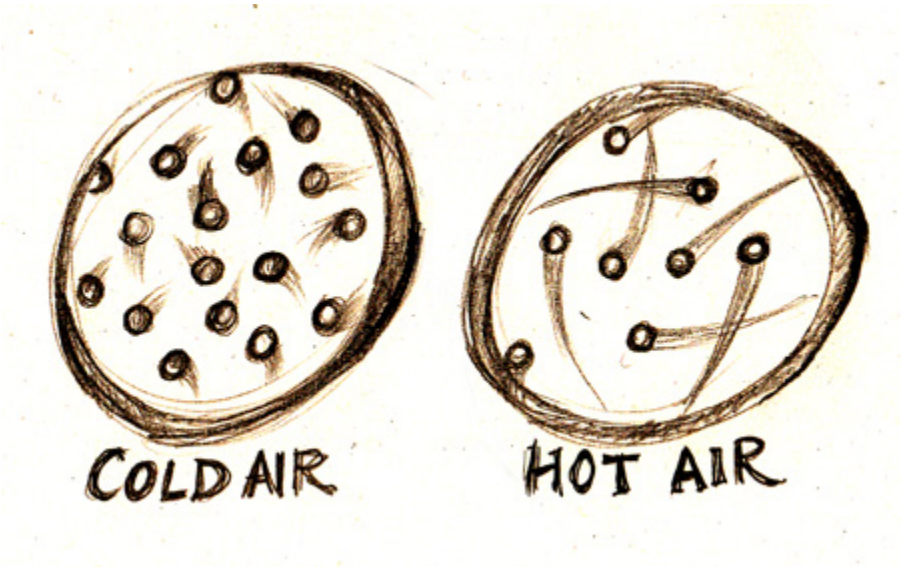
If we think about our log before we split it and after we split it, it's easy to see that the 4-5 sticks we end up with will have a much greater surface area than the parent log. This means more fuel exposed to more oxygen which means more heat.

The sticks are loaded into the stove so they stand on their ends in the feed tube. As they burn they lower themselves into the fire so to a degree they are self tending.

Now you could be forgiven for believing that the flames would just climb up the sticks and out the top of the feed tube and indeed this is exactly what would happen if it wasn't for a phenomena called *draught*.

Draught

As every first grader knows, hot air rises. This is because as we heat air its molecules become more and more energetic and start bouncing off each other, the end result being that the space between the molecules becomes larger so the same amount of air takes up more space. It's now less dense than cooler air.



Cold air is denser because there are more gas molecules in the same space when compared to hot air.

Effectively this means the hotter less-dense air will rise through the cooler denser air just like a hot air balloon rising into the atmosphere. It is this rising of hotter air (or combustion gases) that causes draught.

Now a few factors assist the formation of this draught.

The first is that the stove body is highly insulated. This has the effect of stopping heat loss from the stove and greatly increases the internal temperature of the stove which in turn insures more complete combustion. The hotter the gases, the less dense they are, which means they rise more vigorously.

Another factor is the heat riser. It keeps the gases more concentrated and flowing in a more organized manner than if they were just rising above an open flame where they would be more exposed to wind and heat loss to the atmosphere

Another factor is the smoothness of the surfaces the gases are flowing past. If they are rough they will slow the draught down compared to a smoother surface.

The final factor affecting the draught is the effective height of the heat riser. The higher the riser, the greater the draught. There are a couple of caveats here but for now we are dealing with the broad brushstrokes of how a rocket stove works so let’s press on.

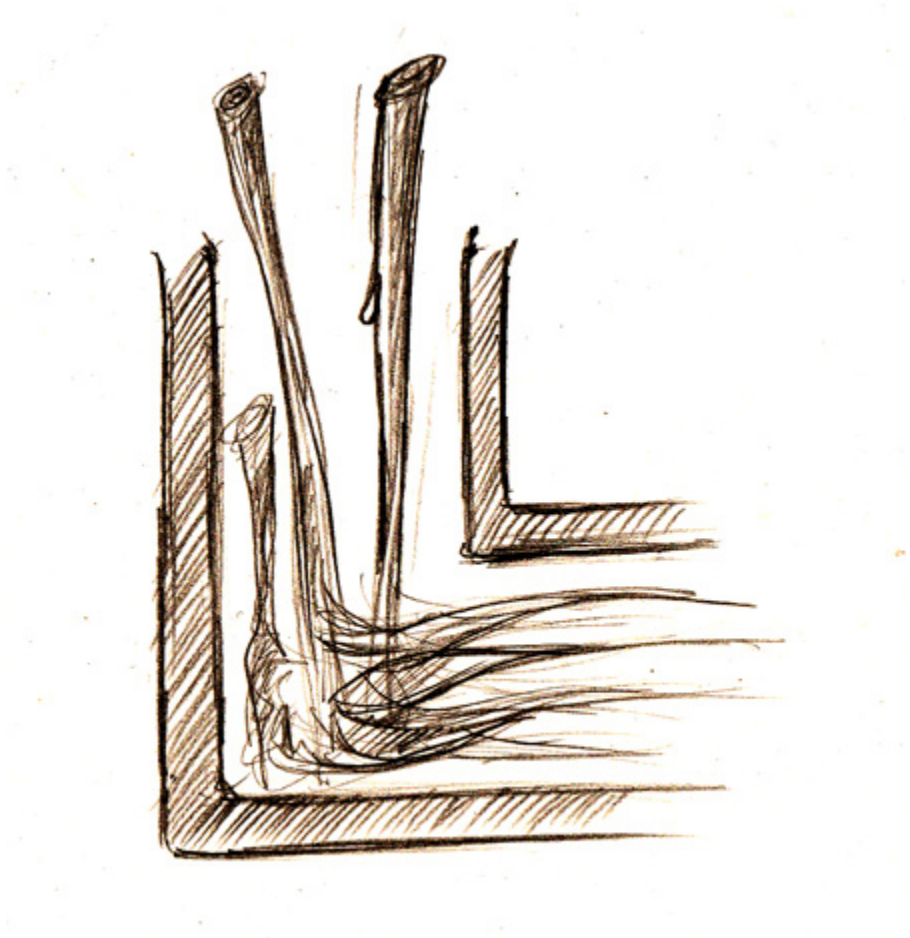
All the conditions inside a rocket stove are conducive to creating a strong draught, high temperatures, reasonably smooth surfaces and a heat riser that focuses the rising gases into a strong organized flow.

The end result is a very strong draught that literally pulls air into the feed tube and draws the flames burning on the ends of the sticks sideways. It also fans the fire just as if we were blowing on the flames.

In fact, the draught is strong enough that a hot running rocket stove will emit a distinctive ‘rumble’ not unlike a rocket engine, hence the ‘rocket’ moniker.

The draught draws the tips of the flames in the direction of airflow (down and sideways into the burn tunnel) but to get to new burnable material, the base of the fire must travel against the flow. This is kind of like the process fire fighters use when lighting a back burn fire, where they start a fire generally from the edge of some break in the trees (such as a road or cleared fire break) down wind of the main fire. This smaller, controlled fire burns slowly against the prevailing wind towards the main fire and through combustion, removes the fuel that the larger, out-of-control fire would use, thus starving it.

The net result in our rocket is that our fire creeps against the draught, heating the fuel in front of it, which then releases smoke which is then drawn through the flame and combusted completely. Imagine we reversed our stick - now we would be heating the wood downstream of our flame, so much of the smoke wouldn’t be passing through the flame and hence not combusting as well. We’ve all seen this when we pile timber onto a camp fire – we are driving off smoke in all directions and not forcing it all through the flames.



In a rocket stove the smoke has to pass through the flames

Dimensions

As we now know in a rocket stove we rely on a strong draught to pull flames sideways. If the draught is too small the flames will burn straight up. Ive already spoken about what gives us strong draught (high temps, tall heat riser, smooth surfaces and same diameter internally). The next piece in the understanding the principles of rocket stove operation is how its dimensions affect the draught.

For a rocket stove to work well dimensions are vitally important.

You will remember when discussing the feed tube I stressed it should be high enough to insure the fuel wood doesn’t topple over and fall out but no higher. This is because the feed tube can form a competing draught for the

heat riser to overcome. If the feed tube is too high you will get a stove that can begin to burn backwards if disturbed either when adding more fuel or from a gust of wind. So you want to ‘bias’ your stove strongly in favour of the hot gases continuing to run out the heat riser.

Keep the feed tube as short as practical.

The second important dimension is the length of the burn tunnel. If it is very long it can make the stove hard to start as it takes more to push hot gases along the horizontal burn tunnel before they can start to rise up the heat riser. The fire naturally wants to burn straight up your sticks and out the top of the feed tunnel so keep the burn tunnel as short as practical. This also has the effect of making the stove more compact, uses less material and shifts the point of final combustion further up the heat riser and closer to its final use (more efficient).

Keep the burn tunnel as short as practical.

The third critical dimension is the height of the heat riser. Simply put it should be as tall is practical

Practical is the important word here. A stove where the hot plate or oven is at shoulder height is useless. We want the cooking surface to be at bench height (typically around 900mm) so that it is comfortable too cook on.

Make the heat riser as tall as practical.

The final piece in understanding the operating principles of a rocket stove is in understanding the importance of getting the proportions right.

Experience has shown that a rocket stove with a square cross sectional between 150 and 180mm wide is an ideal size for cooking purposes and in fact can achieve oven temperatures over 400°C while also being very efficient and easy to operate. Smaller than 150mm and they tend to get more finicky to light and tend to ‘choke’ on coals and ash quickly. My wife Claire cooked for two years daily on a 90mm cross section rocket oven which easily reached around 300°C. That was more about me exploring the lower bounds of what is practical, it’s always better to have a little more fire

power and not have to use it than have just enough and struggle with heavy usage.

Materials

Rocket stoves can be built from almost any fireproof material – from the exotic and expensive, to the cheap and common. I have built from exotic materials such as ceramic and mineral board normally used in kilns and high temperature furnaces and while these materials work wonderfully well, their additional cost and difficulty in utilising in simple rocket stoves must be balanced against the gains they provide. This leads me to believe they should mostly be reserved for special purpose designs, the chief one being portability.

Bricks

I favour old bricks of the low-fired type, simply because they offer a good balance of durability, performance and cost. These can generally be recognised by their orange-red color, and the lack of holes through the brick, often too, these bricks will have been used with a lime mortar which is great because it is so much easier to get off the bricks than cement.

At some point in building the stove body from brick you will need to cut at least a couple of bricks to size. This is perfectly normal. What I do is mark where i want my cut all the way around the brick and then soak the brick in water for a minute or two to keep down dust. I then fit a masonry blade to my angle grinder and I also wear a dust mask and safety glasses and go around the brick cutting down as far as I can along the line. A tap with a hammer will usually break the brick along the line and rubbing the two cut edges together will wear off the spot where the bricks broke apart.

Around 50 of these bricks will allow you to build a rocket stove large enough to power a number of heating devices from ovens to hot water heaters to house heaters. In this booklet we will deal with ovens only.

Clay slip

Clay slip forms the basis out of which we make all the other mixes for the stove. It is simply clay mixed well with water till it has the consistency of thickened cream. You will need some dry clay soil, free of organic material and sift it through a piece of mosquito mesh 0.7mm (but up to 2-3mm is fine. If the material isn't sifted, larger bits of stone or gravel will sit between the bricks and stop them settling flat. If you don't have access to clay soil you can buy a bag or two of fire clay powder for between $20-$30 a bag. Make the clay slip by adding the clay powder to a container filled with water and stirring with a paint mixer attached to a drill. If you drag your fingers through it it should leave tracks, or if you splash it, it should leave splotches on the surface. Work from a thin mix up to the correct thickness. You want the mix just thick enough, not just thin enough.

Mortar

Mortar is what we use to seal and level the bricks when building the stove body. For the mortar, mix the slip and some builders' sand at a ratio of three sand to one of slip till you have a stiff mud. I say builders' sand because it's cheap and easy to get hold of. If you have a local source or other sand, then go for it! This is the point where you get your shoes off and walk and stomp the sand and clay mix together to achieve a nice consistent mix. An old tarp to mix on is a great help here as it stops you making a big muddy mess. It also allows you to drag two corners of the tarp up and over as if you were folding it in half. This recenters the cob into the middle of the tarp and tumbles it to achieve even better mixing. Do this a few times during the mixing process.

Cob

For our purposes here, cob is simply a mortar mix with some natural fibre added to give tensile strength. Usually this will be straw but you can use any natural fibrous material. Cob houses have been built for centuries and many books written on the subject. As we are talking about people living in the cob buildings, a lot of time and effort goes into getting the mix right. For building a stove body we don't have these concerns as the stacked bricks with a layer of mortar between the joints is more than stable enough. We then add an outer layer of cob to bind the structure together making it into a monolithic structure. It also looks awesome! How much fibre to add

varies widely depending on what you are trying to achieve but again for us it doesn’t really matter. For a starting point try a bucket of fibre to a bucket of mortar mix and go up from there. If straw is hard to get where you are sugarcane mulch works really well too.

Insulating cob

Insulating cob is the name given to a cob mix where we are trying to incorporate as much air into the mix as possible. We are not trying to achieve tensile strength here so we don’t add long fibers like straw, we are trying to make a mix that will slow the passage of heat out of the stove body. To achieve this we can use a few different materials. More on this later.

Ingredients

Ok, we’re about to start the process of demonstrating how to construct a simple rocket stove base. This base or ‘power unit’ is common to both the black and white ovens in this booklet and indeed to a number of other rocket stove projects which will be the topic of further booklets.

Rocket stove power unit

To build your rocket stove power unit you will need:

- Around 50 bricks
- 1 wheel barrow of either fine sawdust (sawdust, not wood shavings), perlite or vermiculite. Perlite or vermiculite can be found in 100 litre bags – usually around $30 – at hydroponic stores. Don’t buy in small lots as it will cost a fortune.
- 2 wheelbarrow of sand
- Some clay slip, about one wheelbarrow's worth. (Obviously we’re not talking about you buying expensive potter’s clay -- what you have in the ground will usually do or you can buy fireclay powder for around $30 a 30kg bag. Check out how to make the slip further along in the text.)
- A tarpaulin or area to stomp cob
- 1 metre of 150mm flue pipe if building optional heat riser.

Tools/equipment required:

- Wheelbarrow
- Shovels
- Buckets
- Drill and paint stirrer
- Level
- Tape
- Tin snips
- Sieve if you are sourcing your own clay(mozzie mesh will do).

Black oven

Materials list for black oven:

- 1 old oven, gas or electric. I've never had to pay for one as they can be found as a give away but otherwise from your local scrap dealer.
- 2 meters of flue 150mm
- 90° elbow to suit flue
- Old baking tray
- A couple of square meters of bird mesh (chicken or square – it doesn't matter, and it can be in bits and pieces).

Tools/equipment required:

- Tape measure
- Tarpaulin (to mix the cob on)
- Shovel
- Trowel or spatula
- Safety glasses and earmuffs
- Small angle grinder with thin cut-off blade
- Drill and small bit 6-8mm
- Pliers and/or tin snips
- Screw drivers
- Mosquito mesh or large kitchen strainer (don't let the cook see you take it!)

White oven

Materials list for white oven:

- 2 x 200 litre barrels
- 2 x hinges for door
- Small bolts to attach hinges
- Pack of fibreglass insulation batts
- 2 -3 old oven racks or suitable mesh off cuts (not galvanised)
- 4 sheets of old corrugated iron
- 1 meter of flue 150mm

- 6 x 6mm bolts over 40mm long and nuts (cheap ones called gutter bolts)
- The rocket stove power unit is exactly the same as for the black oven.

Tools required:

- Marking pen
- Tarpaulin or flat area (to mix the cob on)
- Shovel
- Safety glasses and earmuffs
- Small angle grinder with thin cut off blades and grinding wheels
- Drill and small bits
- Pop riveter and rivets
- Hammer
- Pliers
- Tape measure
- Tin snips
- Screw drivers
- Mosquito mesh or large kitchen strainer
- Stanley knife (AKA ‘boxcutter’ in the US)

Building your rocket stove ‘power unit’

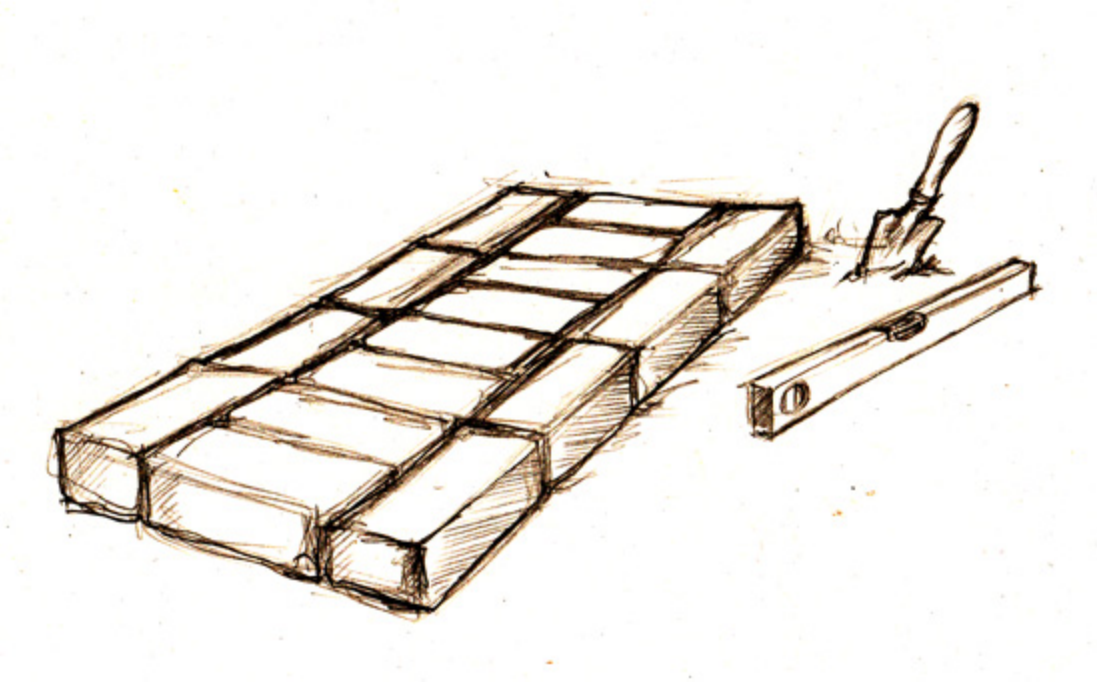
The mock up

Prior to building the final complete stove, it is really important to do a mock up, so that we can work out any design bugs sooner rather than later. One important thing to note here is that the feed tube can be in any orientation to the heat riser. There is a natural tendency to have the feed tube facing the front of the oven but it can also be to the left or right or even towards the rear of the oven. I have built in all the orientations mentioned either to fit into a particular space or in the case of ovens that are completely out in the weather; to tuck the more weather-vulnerable stove base under the oven body.

So, on a flat fireproof surface, either where you wish to build your stove (a good idea) or nearby, lay out a row of clean bricks with the long sides of the bricks touching. At this stage, we won’t be using anything to stick the bricks together, as this is purely to check final dimensions and such

The number of bricks we lay out is determined by how long the stove we intend to build is. This will depend on your application, but I have found that the shorter the stove, the easier the stove is to light and the more efficient it is, as we are not heating extra mass for no good reason.

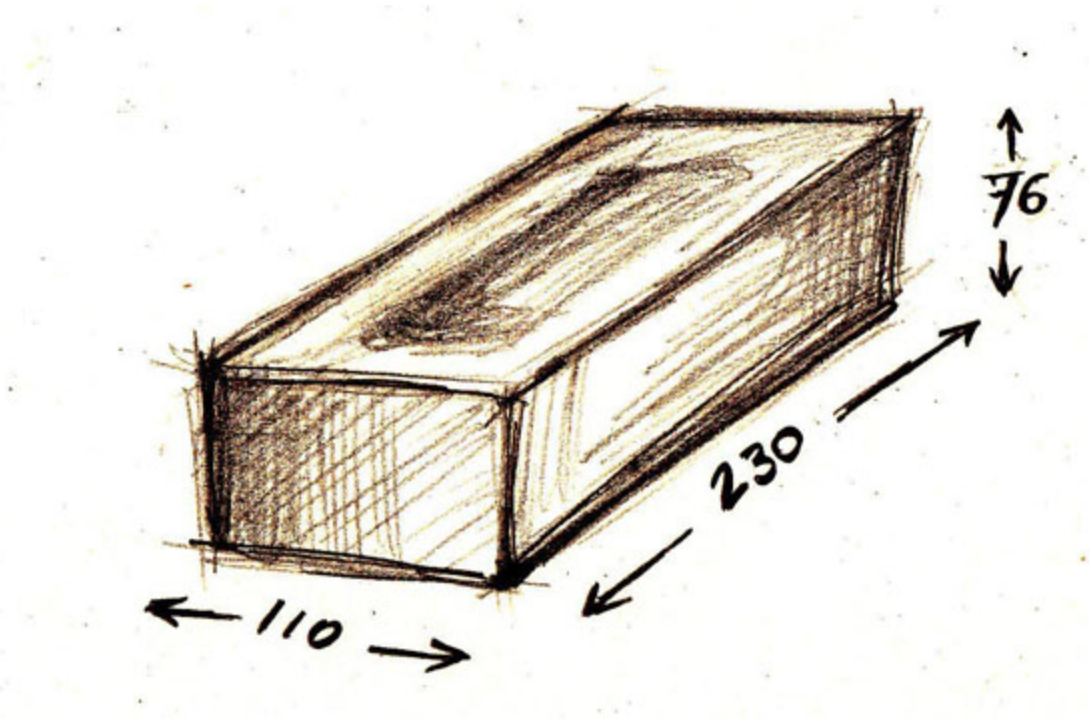
Next, lay out a perimeter of bricks around the central row. I lay out a bigger base area than I need and just remove the excess bricks afterwards.



The brick base

We then begin building up the sides of the rocket stove by placing the next layer over the join between the perimeter bricks and the inner row. Depending on your brick sizes, there will be two courses of bricks in the side wall, in what is known as a running bond. This is simply the overlapping of the joins for a stronger structure. If you want to see a running bond, find any brick structure and see how all the joints are staggered. Having said that don’t be worried if you get a spot or two in your stove where you have a joint in one row of bricks lining up with another; you are building a stove not a nuclear power plant. The assembly will not be subject to any real structural forces and will be more than strong enough no matter how poorly you build it, so relax a little. Don’t worry about slight variations in bricks sizes as they can be swapped around a little to get the best fit and when we rebuild for the permanent installation, we will be using a clay/sand mix which acts as a gap filler and leveller.

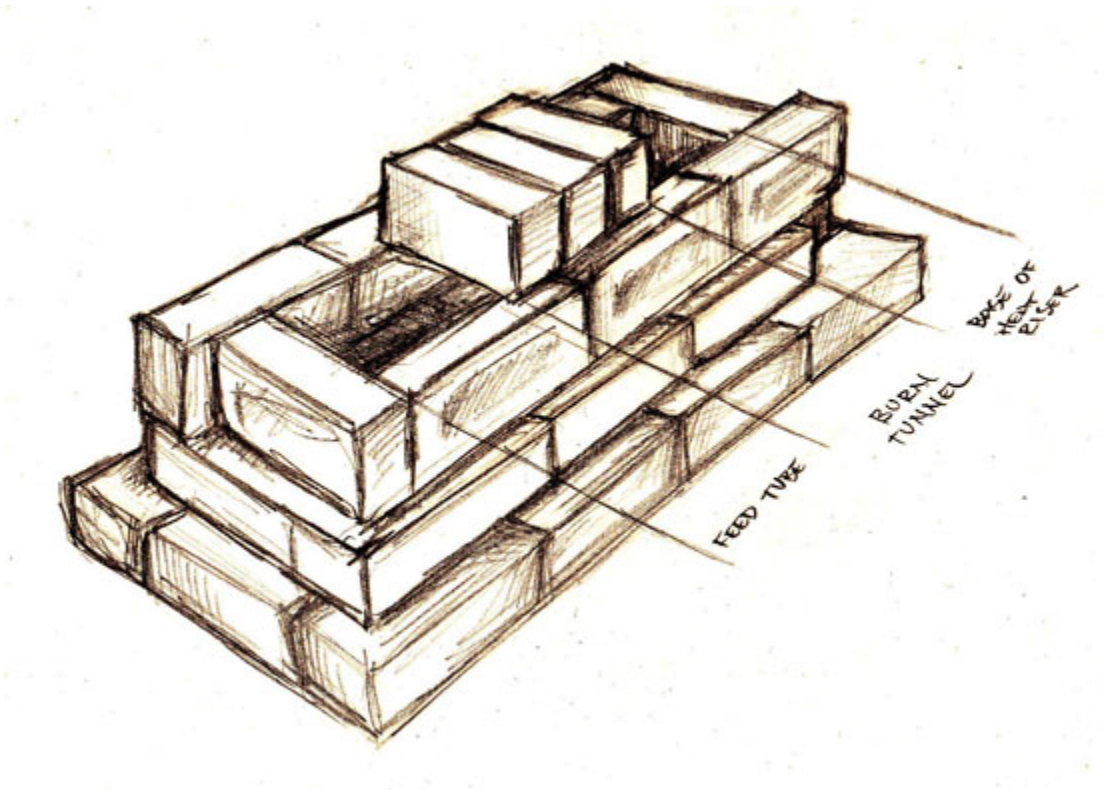
The width of the burn tunnel is limited to the distance the bricks can span to form the *roof* of the burn tunnel. I like to leave at least 25 to 30mm (1"-1¼") of overlap on each end the brick which, with a common brick, gives a span of approximately 170mm (6½").



The length of this standard brick will determine the maximum width of our burn tunnel, as it will form part of the roof. (See next diagram for the example.) Take the 230mm length and subtract about 30mm overlap at both ends, which leaves about 170mm for the burn tunnel.

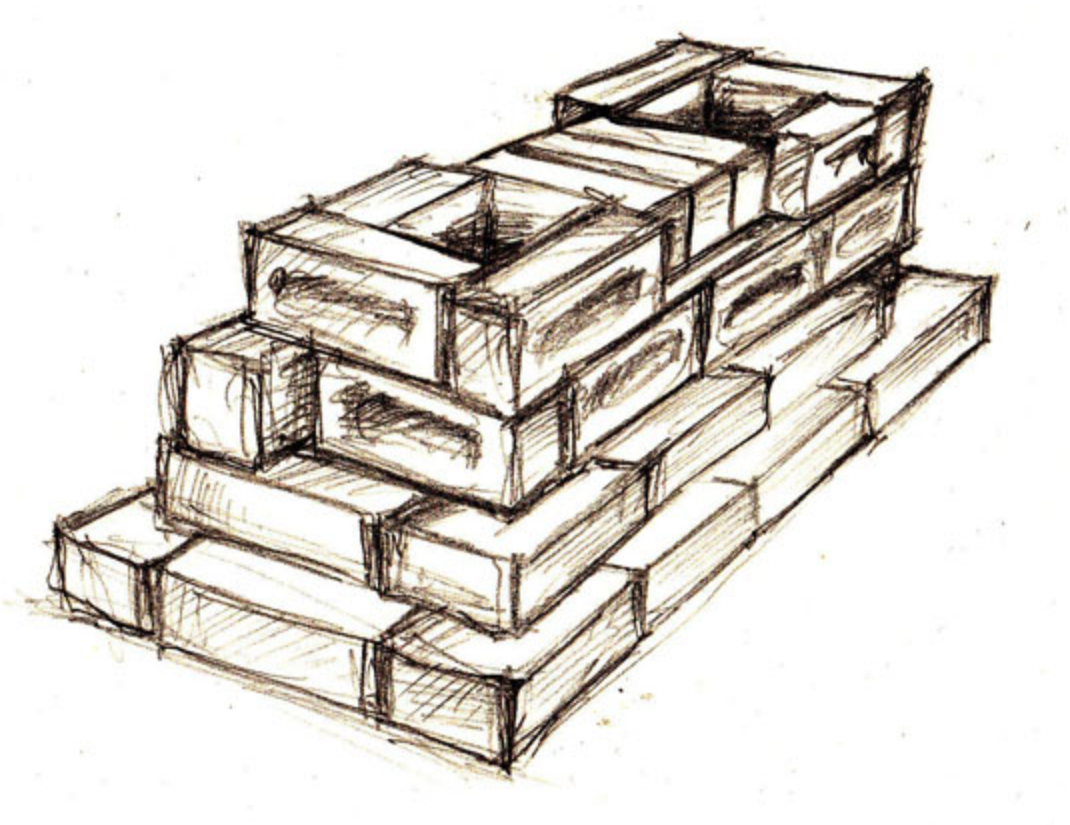
When building rocket stoves, it's a good idea to try and keep the cross sectional area of the feed tunnel, burn tunnel and heat riser as uniform as possible for the best possible gas flow. So, if the maximum possible span over the burn tunnel is 170mm, then something close to this is desirable for the wall heights. If you stack the bottom brick flat and the next brick on edge this will give you 186mm. While this is larger than our ideal it errs on the side of being larger and therefore less restrictive plus it gives more room for cleaning out ash and also means you can leave the ash longer between cleanouts. Great if you are lazy like me.

This is where the real world meets theory and while it's great to have everything perfect, it's not a deal breaker. There's a saying I love that goes like this: "In theory, theory and practice are the same. In practice, they aren't". Too often, we chase absolute perfection in these designs and end up with exotic materials, a lot of headaches and not much real world difference in performance. Remember, we are using recycled materials, so relax and as long as you're getting it mostly right, you'll be fine.



The area where the bricks span the roof of the burn tunnel is subject to the greatest stresses, so we lay them on edge. In this position they are stronger and more able to resist the hot-cold cycling of the stove body. I've already mentioned that I try to keep the burn tunnel as short as possible, but that will depend on your application. For rocket ovens, this generally means two or three bricks in the roof of the burn tunnel. One implication of this is that the feed tube won't stick out so far from the base of the oven to be a trip hazard.

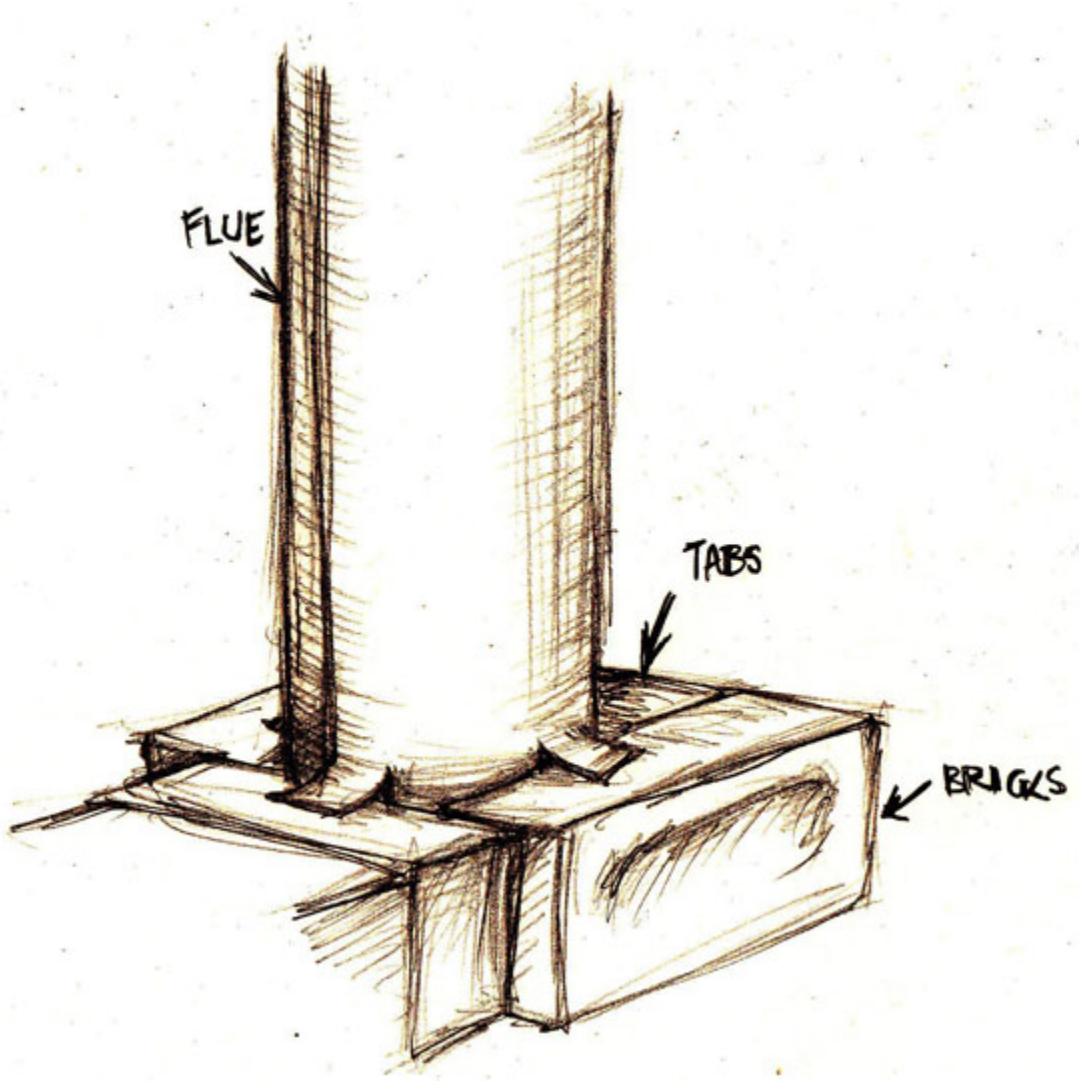
Once this is done, stack up the feed tube where we feed the fire. Keep this as low as possible, while still providing enough support for your fuel sticks so they are not falling sideways as the tips burn off, but are slowly lowering themselves into the feed tube. This will generally be three courses of bricks from the layer that forms the base of the stove. At the same time, we can start to form the heat riser to an equal height on the other end.



The mockup showing the feed tube to final height. If we were building the stove body all in brick we would simply continue the heat riser upwards with brick courses.

Next, there is a decision to make regarding the heat riser. This can certainly be built to full height using bricks stacked on their edge, or we can use an alternate method and use an all-steel riser.

If you can find some 150mm stainless flue material, you can use it for your heat riser. Now it is a little smaller in cross section, but as stated earlier, relax a little. For one thing, the round section generally has much better flow characteristics than square tunnels and being smoother than bricks, will have less drag – so, close enough. Now, take the stainless pipe and cut it to the length required for the application. Obviously, don't do this till you're absolutely certain of the exact length required. We then cut some tabs on the bottom and bend them out so they sit on top of the bricks and hold the riser up and in place. You can slide the bricks the tabs are resting on a little closer together so that the riser is well supported.

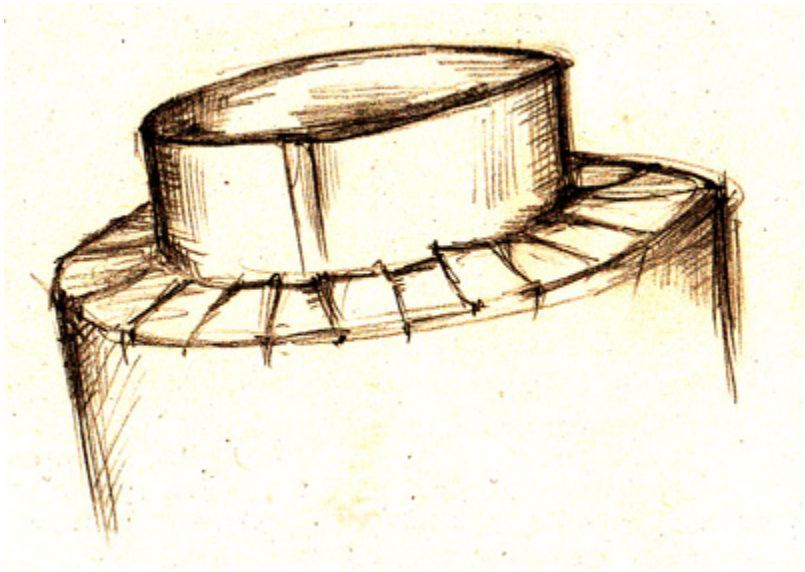


This is the optional stainless flue pipe heat riser. While I'm sure it will eventually burn out, I know of one installation that has seen daily use since it was installed three years ago and is still going strong.

While we will be covering the whole stove in an insulating mix later, a further variation for the stainless steel heat riser is if we can source or bend up, a steel tube at least 75mm larger in diameter than the riser. It doesn't have to be thick or of stainless steel, in fact I have made these out of old corrugated iron hammered flat and then screwed, pop riveted, wired or tabbed into a tube. Remember you won't see it, so it doesn't have to be pretty.

Make this outer tube the same length as the inner tube and then go round both ends and cut slots about 25mm deep and 25mm apart. If we bend all

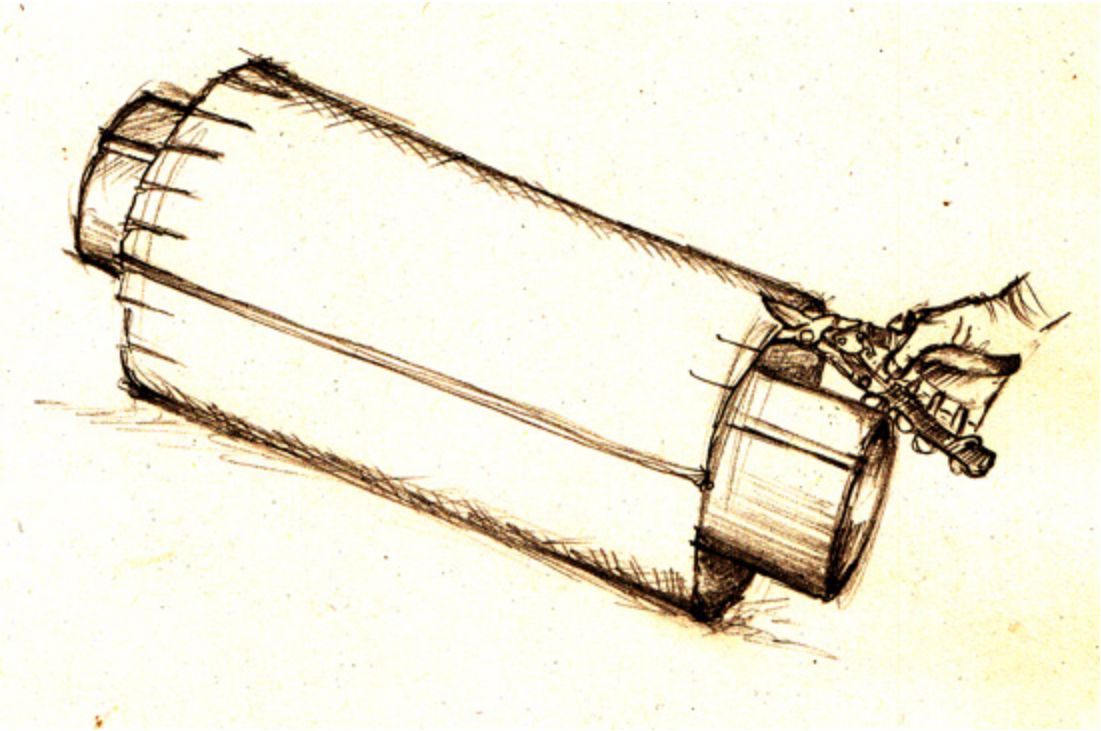
these tabs in on one end, they should all close in around the inner tube with no gap. If not, cut your slots a little deeper.



Here we see the tabs bent in closing the gap between the heat riser and the outer tube. Our next step is to turn upside down and put a few handfuls of cob between the tubes to seal the gaps between the tabs. This allows us to backfill with perlite or such and then cap off with cob, and bend the other tabs in locking the two tubes together and the insulation between.

Turn the tube upside down and drop in a few handfuls of cob mix between the inner and outer tubes and tamp in place. Then, depending on what is available, backfill with crushed pumice, perlite or vermiculite (watch the dust, it is an irritant if inhaled) and then cap off with some more cob and bend the top tabs over to form an insulated tube.

Because there is now a step in the outer profile of the heat riser, we can rest the step on the top of the bricks to support the riser. Now the heat of the stove is such that even stainless steel will eventually degrade but it generally takes years so a minor rebuild of the heat riser every few years is a small price to pay for more efficient stove. You can of course make the riser out of heavier steel if you can get some (stainless or more typically mild steel) and it will last a very long time but make sure it’s close as possible to the correct cross section.

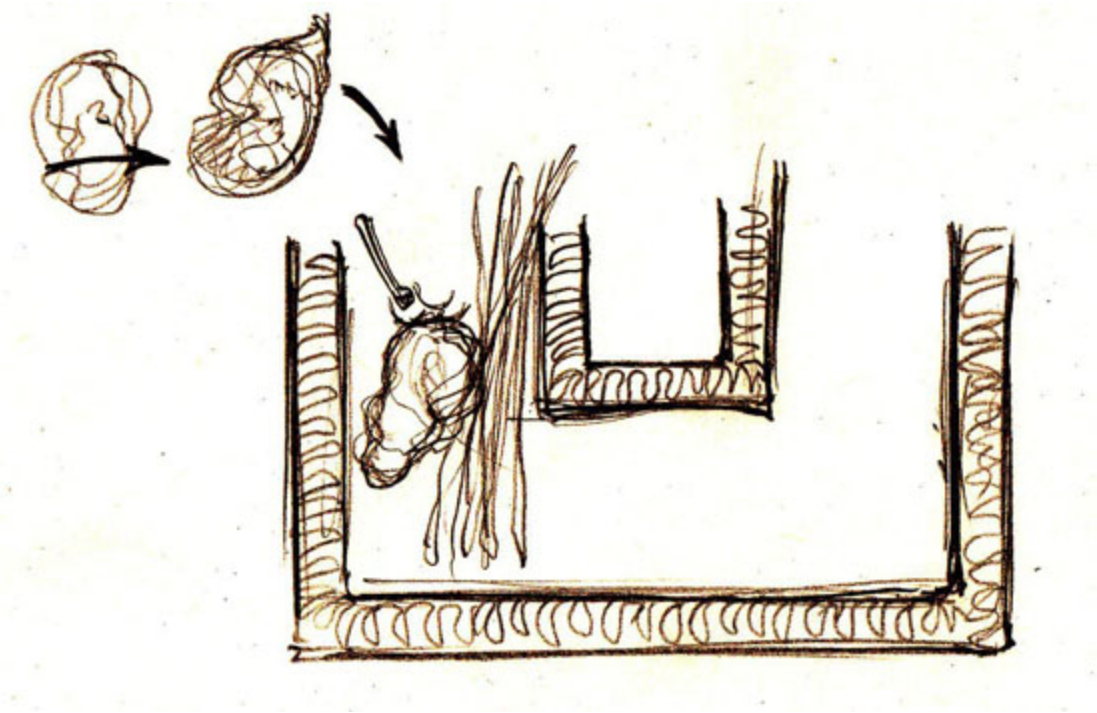


And that’s the rocket stove ‘power unit’ done. This unit can be used wherever you have a heating need. Now remember this is a mock up so that you can work out your final build. Any gaps will be filled with clay/sand mix in the final build. Having said that, you can test fire the unit just to see how it runs, however with all the gaps it generally won’t draw well, so I just cover the outside with some of my cob mix to seal everything and then light it up. As there will likely be lots of wet cob mix exposed to heat, don’t expect the stove to draw as well as when all the materials are dry, but you will get a good indication of how well it will work.

Starting the stove

Starting a rocket stove is like starting any fire in that it is 90% preparation and 10% application. Make sure you have lots of fine split kindling. I then crumple a half sheet of newspaper and sit it in the bottom of the feed tube and sit the kindling on top towards the burn tunnel like a wall two or three pieces of kindling deep.

Next, rip the other half sheet of newspaper into 4-5 pieces and ball them up lightly. I light one and when it’s burning well, drop it in behind the pieces of kindling. As the fire catches, drop a new ball of newspaper in as the previous one begins to burn out. At this point, give a strong puff of air down into the feed tube and the flame should start to draw sideways and into the burn tunnel.



Pretty soon the kindling will be burning well and when it is, feed in the larger pieces of timber behind the burning timber as we want the fire to creep backwards against the draught, remembering that too big a piece won’t burn well until the stove is up to temperature. Also, these stoves don’t like single pieces of timber burning in them. I find once hot, three largish (30mm- 75mm) sticks will burn steadily and happily.

Of course, these are all generalisations and at the end of the day, you will have to sort out what works for you. These stoves, while being amazingly efficient, aren’t immune to wet or green timber or poor management, so observe, learn and apply.

Final placement

Once you are happy with how your stove will go together, it’s time to consider where you will be putting it for its final installation.

The thing to remember here is that these ovens, particularly the rocket part, get very, very hot, so make sure you isolate any combustible materials from the installation itself. On a concrete pad or stone floor you will be fine, but don’t rely on thick layers of brick or cob to insulate combustible floor materials from the stove base. While cob and brick may seem only warm to the touch, this is due to the rate heat can pass through them and the rate at which the heat energy passes to the surrounding air. Put these materials up against something combustible (but quite insulating) like a wooden floor and the heat, having nowhere to go, will build to the point the wood will start to smolder. In situations like this, you must have some sort of air gap, a highly insulating mineral insulant or better, a combination of both.

In the past, I have built stoves where the rocket unit is built on a platform sitting 50mm above the floor with a layer of insulating batt underneath. Between the batt and the floor the temperature was below 30°C. The platform in question was the salvaged side of an old washing machine propped up on bricks. I’m fairly certain that because the support was metal, it dissipated the heat faster than it could flow in from the oven body because the metal base was cool enough to be able to leave your hand resting on it, even after hours of cooking.

The final build

We can now reconstruct the stove in its final position just as described above, however this time we will be mortaring the bricks together. This serves to stabilise the stove body, fill any gaps and level the bricks. It is not to ‘glue’ the stove together.

This layer can be really thin or thicker if we have to level a smaller brick with a larger brick. Dip the bricks in water before you mortar them as the dry bricks will suck moisture out of the mortar rapidly, giving you little or no time to bed the bricks in place. Pay particular attention when placing the bricks as this will be their final position. Make sure the inside of the stove is as smooth as possible with none of the bricks jutting out past the others.

The Insulation layer

Once we have assembled the stove using the mortar mix we can then cob the completed power unit and make it pretty. We will do this in two layers. The inner insulating cob layer can be achieved a number of ways. The first way is we mix in a material to make the mix lighter and more insulating. Usually I use perlite which is a product made from obsidian stone that is popped at high temperatures like popcorn. It is inert and nontoxic, but the dust can be irritating if inhaled so use a dust mask when working with it. It is used in potting mixes or in hydroponics.

Other products that are also suitable are: vermiculite, a mineral-based material much like perlite; crushed pumice, if you are lucky enough to have a local source; or sawdust. All these materials work by entrapping air in the mix but in the case of the sawdust it does this by burning out and leaving tiny voids in the mix when heated up sufficiently.

Blending the insulating mix is the next step. I do this by putting clay slip in a large tub and pouring some of the insulating material on top, mixing it in the top layer and then scooping off. We are trying to get the insulating material to stick together using the least amount of clay slip as this will give us the best insulator. It doesn't have to be strong as we will be covering it with a less insulating but stronger mix, it just has to hold together long enough to be coated with our outer layer.

Your next step is to begin sticking the mix to the outside of the stove body. Smear a coat of clay slip using hands a rag or brush to the outside of the stove and then working from the base up layer the mix between 25-50mm thick against the stove. Don't try and push it and make it stick to the stove so much as stack it on top of itself keeping the top flat. The more you push it against the side of the stove the more likely it is that it will fall away. Do this till you are approximately 25mm below the level of the top of the feed tube all the way around the stove.

Laying the insulating mix against the side of the stove.

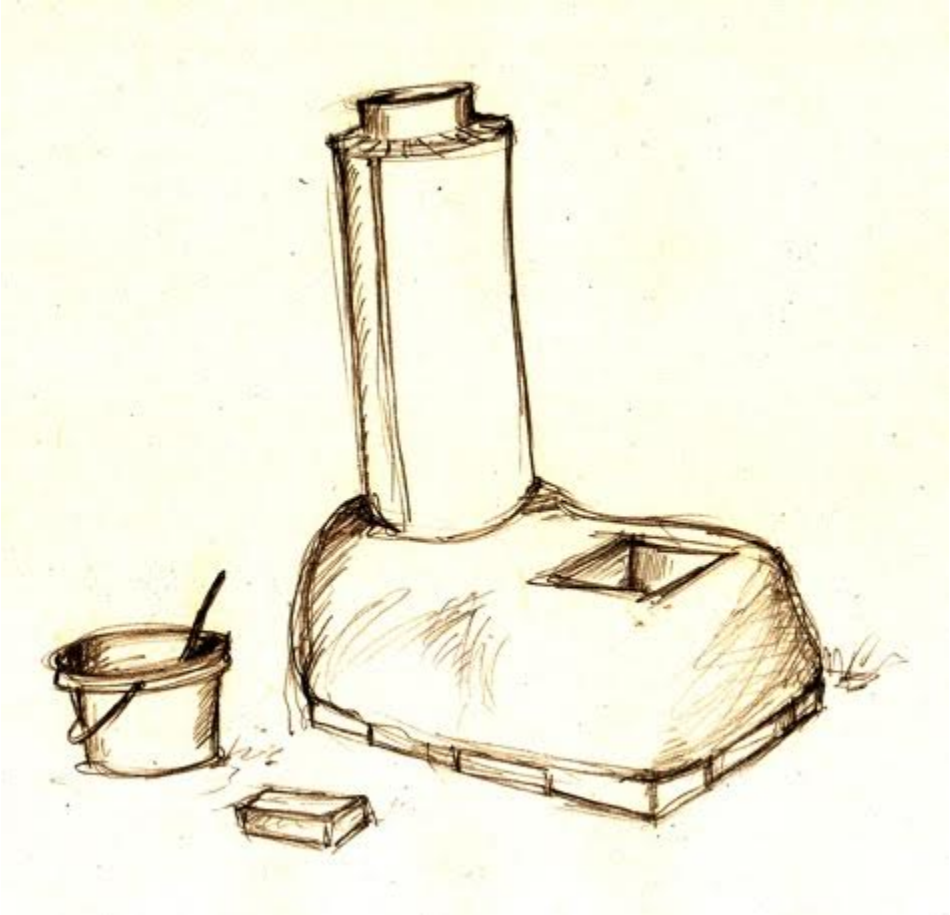
This layer will be very brittle, so get some bird netting and wrap a layer of the netting around the base of the stove to the height of the insulating layer and twist it together using the cut ends of the wire. Don’t bother twisting every end over – just enough that it holds together; remember, it will be covered in a layer of cob. Just make sure the sharp ends are pushed back into the insulating layer as you don’t want to cut your hands when applying the next layer.

Next, add insulating mix to the top of the stove body, joining up with the insulating material on the sides. Leave it clear of the top of the bricks

forming the feed tube, as any material here will get broken away in daily use.

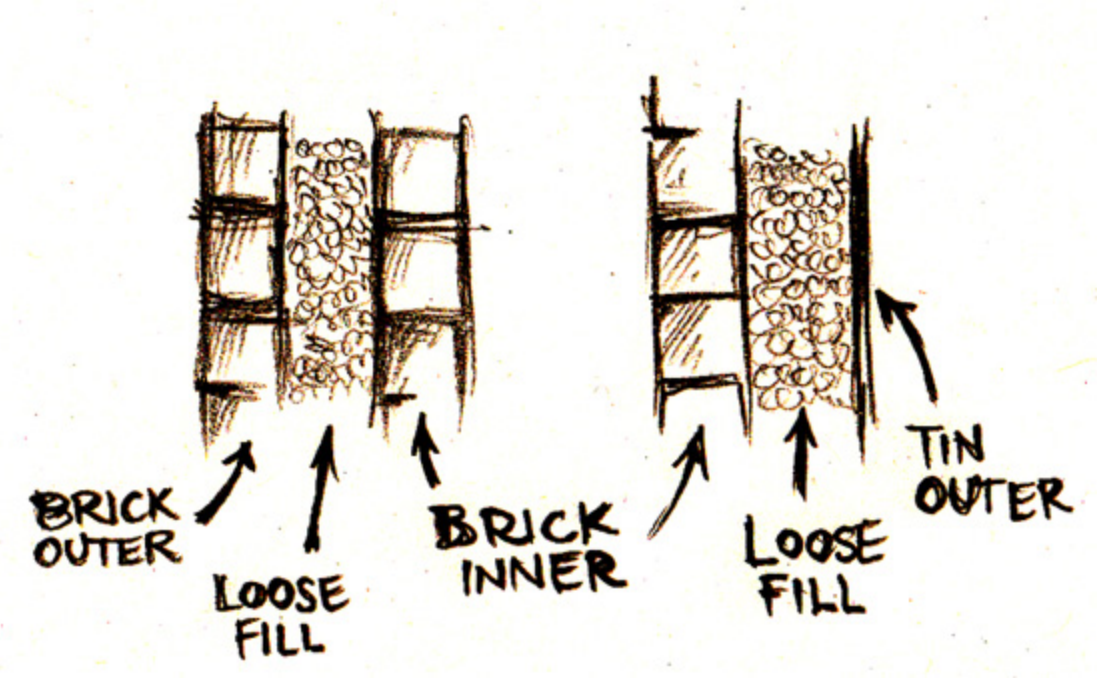
The next step is to make a standard cob mix with some chopped straw or sugar cane mulch, this is both for looks and to add some tensile strength but remember you have the bird wire to bond to and this will add all the strength you need. Apply this layer to the outside of the stove body again leaving the top of the feed tube bricks clear. This layer doesn't need to be any thicker than 25mm.

Once this is done you can repeat the same process on the heat riser starting with the insulating layer and going up in stages and stabilizing the lower stages with bird mesh as you go. I normally like to leave the last 100mm of the heat riser uncovered so that when we are making the join between the rocket unit and whatever is being heated, we can build it to just the right height and dimensions.



The completed stove showing the double skinned heat riser.

Another method I have used is to loose-fill perlite around the stove body. What we do here is to form some sort of enclosure around the stove and pour in the perlite. I have used sheets of flat tin but by far the best looking way is to build another outer layer of bricks around the stove body and pour in the perlite. Often I will use a hybrid method and do loose fill around the body of the stove and do a clay slip insulating mix around the riser.

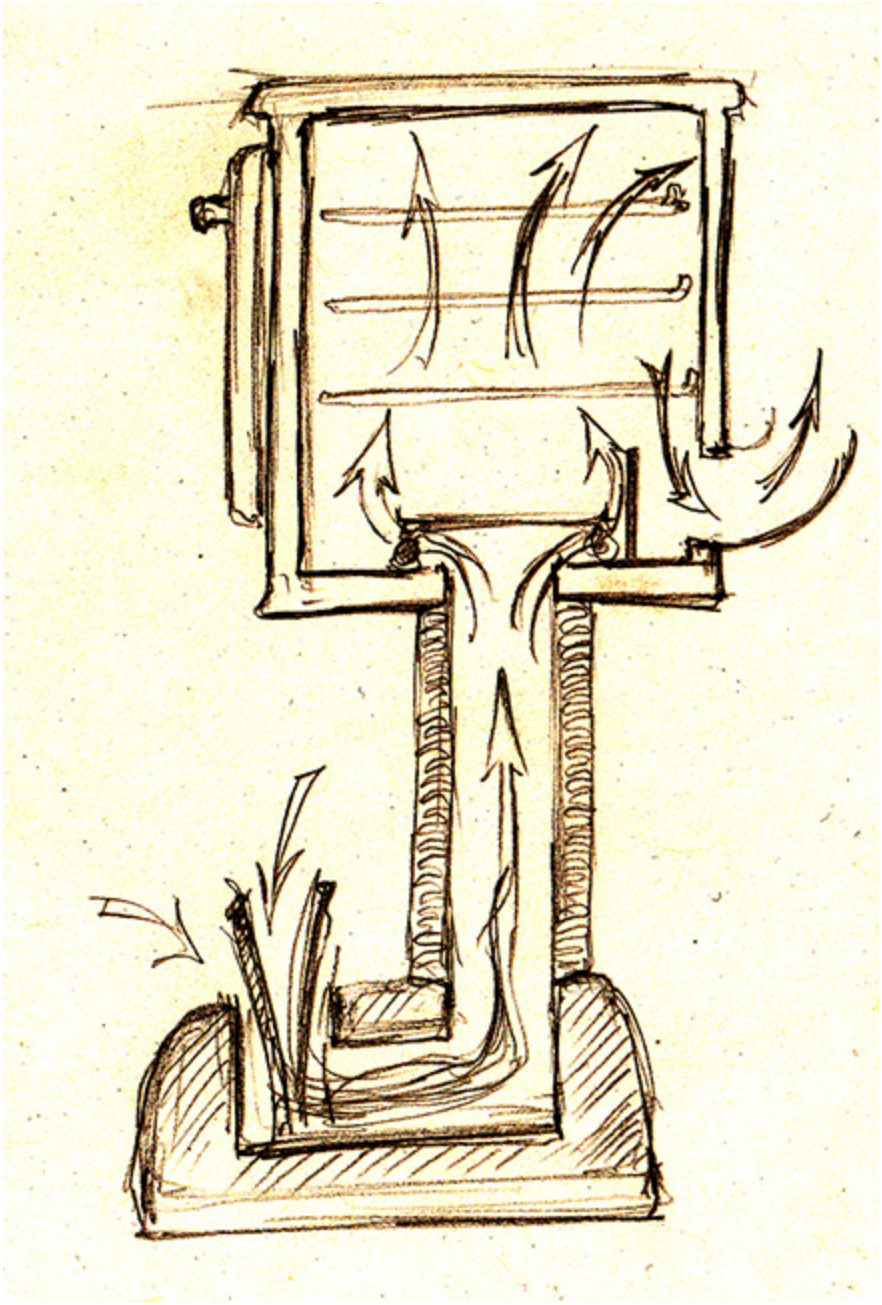


Insulating the stove body with a loose fill of perlite or vermiculite contained inside either an outer layer of bricks or tin.

Building a black oven

Now that we know how to build the power unit (rocket stove) it's time to get down to the nitty gritty of constructing the oven itself. In this booklet we will describe how to build two different types of rocket ovens. The first and easiest is known as a black oven. This simply denotes that in this oven the food is exposed to combustion gases. Now before you go "ugh!", this is exactly the same as a large wood-fired pizza oven. A lot of the time these ovens will also have an ongoing fire to extend cooking times. The major difference being that our oven will use vastly less wood and the wood used would be considered little more than sticks at that. This is because in our oven we use the heat of combustion to cook the food directly. In a traditional pizza oven, the wood is used to heat the mass of the oven, and then uses the heat re-radiating out of the mass of the oven to cook the food. These extra steps lose precious energy and take time as the mass of the oven heats.

In our low mass oven, we are heating a much smaller mass and a few kilos of food, not 200+ kilograms of dirt and a few kilos of food. This means that in as little as 5 minutes, we can be cooking, as opposed to a 2-3 hour preheat for a cob pizza oven. One thing needs to be noted here, just like a wood-fired pizza oven, the quality of your wood is paramount because your food will be exposed to combustion gases so don't use pitchy (sappy) woods and never ever use painted or treated wood. In fact, never burn treated or painted wood regardless of whether it is a black or white oven.



Cross section of a black oven. Note that the exit flue can also be out either side rather than the back. I have even had no exit flue but simply propped the oven door open a fewmm.

When I first considered building this oven I was a little put off by all the extra work that would be needed to construct the box of the oven with a door, shelves and then to insulate it well enough that we weren't wasting heat.

As I started to work out how to build it, the thought occurred that all the essential components already existed in the form of scrap gas or electric ovens. Generally, the cabinets are serviceable and faults, if any, are in the control or heating components of the units. A lot of the time someone is just remodelling, so the perfectly good old stove gets tossed. Well, now there is a great way to give a new lease of life to these old stoves.

We have already gone through the rocket stove construction process, so we will start from the point where we have constructed the rocket and are looking at adapting the old oven for use.

Firstly, consider what type of oven will work best. Units that have the hot plates beside the oven are the best, as we can quickly unbolt the hot plate unit and return it to the scrap pile. The oven part will have a nice flat top and look made for its new purpose. Having said that, these units are harder to get hold of these days, so you may have to content yourself with a unit that has the hot plates on top or rarer still, a wall mounted unit. The main message is it doesn't really matter, all will work but some may take a little more effort to strip all the unwanted stuff off.

Check the oven you are considering, to make sure the door works okay and the seals are in good condition.

Now, take out all the racks and rack mounts which are generally hooked into the oven walls.

Next, remove all electrical wiring and all the heating elements, you won't be needing them!

If you have a fan forced oven, remove the fan (we can usually block the hole left behind with offcuts from the cabinet or some aluminium foil backed by the insulation recovered from the hole we are going to cut in the base of the oven).

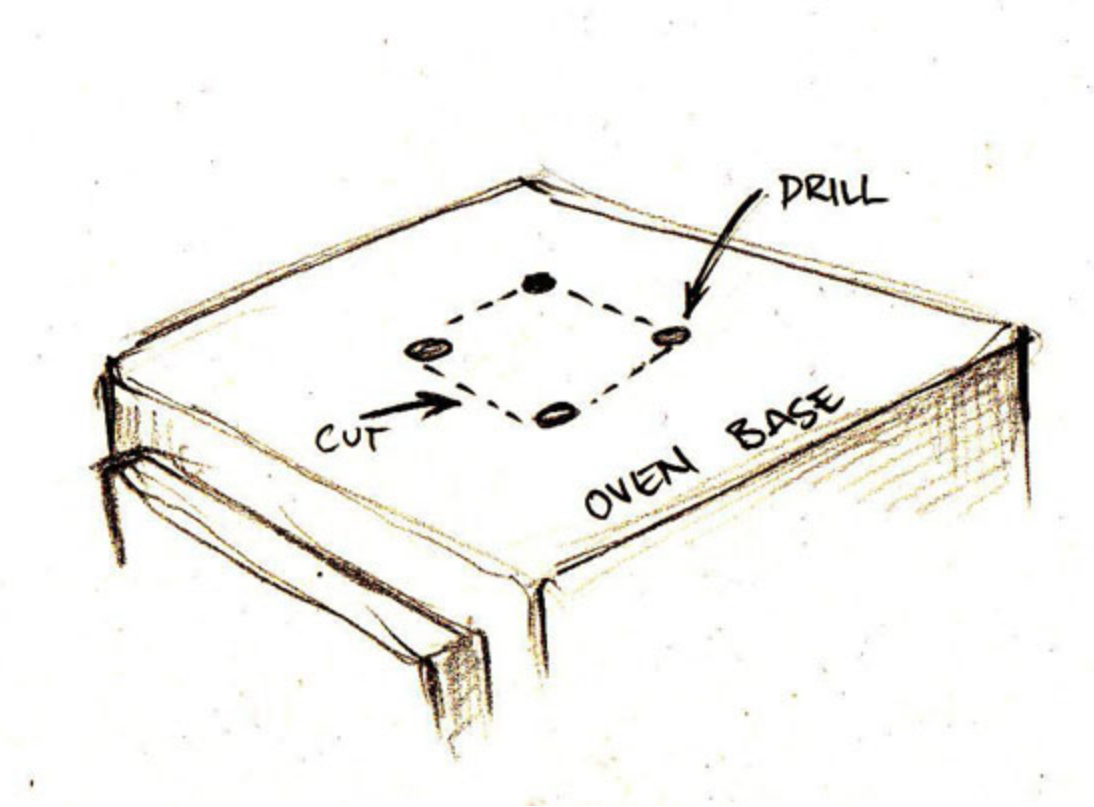
Remove the door. Every oven door I've come across is designed to be easily removed for cleaning. Generally, you open it fully and then lift at the base of the hinge. Regardless, there will be a way, even if it means a little fiddling on your part. A word of caution though - the hinges are spring

loaded. When you open the door you are stretching the spring. If your finger or hand is under the hinge when it flicks back, you will know it.

We are almost ready to get cutting, but first we need to know where to cut. Measure the dimensions of the opening in the top of your rocket unit and transfer those dimensions to the centre of the base of your donor oven with a marker pen. Take the drill and small bit and drill through the base of the oven at each of the four corners. Keeping the drill at 90 degrees to the base, drill first through the outer case and then through the inner case.

Next, grab the angle grinder with the cutting wheel fitted and cut between the four holes you have just drilled. You should now be able to remove that section of the outer skin of the oven. Below will be the insulation. Generally, this is fiberglass, so be careful as it will make you itch if you get it on yourself. Gently tear it in the middle and squash it back between the two oven skins out of the way, or if you have a fan hole to block and insulate, pull it out and save it for that purpose

Next, we simply get the angle grinder and cut between the holes on the inside of the oven and – hey presto! – we have the opening for the hot gases to pass into the oven. I then roll a sausage of alfoil and jam it between the gap between the inner and outer skins around the hole so that no fibreglass can get into the cooking chamber. I will also smear some cob to seal it off really well.



The black oven base showing how we mark and cut the opening for the hot gases to flow into the oven.

If you have taken the option of constructing a metal heat riser for your rocket, then you will still need to transfer circular dimensions to the oven base. I find the best way is to make an accurate cardboard template of the flue pipe and then trace around it onto the oven base. Drill all the way through at four points along the circumference. 12 o'clock, 3 o'clock, 6 o'clock and 9 o'clock. Then, take the template and lay it for best fit over the holes on the inside of the oven and draw the outline onto the oven floor. Drill lots of holes (almost touching) along the outline and grind away between them. Do the same for the outside. The reason for drilling lots more holes is that the curve of the circular shape makes it hard to cut properly as the cut off blades only cut in a straight line. Also, only use the tip of the blade as you cut and cut gradually all the way around rather than straight through in one go in one spot.

•

So we've managed to give the gases a way in, now we need to let them out.

This is exactly the same as the hole to let the gases in, but here it will be a hole sized and shaped to fit the flue elbow.

If the oven is outdoors, you can actually just make the hole and let the gases exit directly out of the side of the oven. In initial testing of the design, I just propped the oven door open with a small stick 6-10mm wide to see the effects of different exit sizes. But you end up with smoke stains around the door and the side of the oven. This is where real life testing is invaluable though, because what I found was, if there is too big an opening to allow the oven to draw better, it can actually cool the oven because any air entering the oven over and above what is consumed by the fire, just cools the fire.

Another point to emphasise is that the hole put in the oven to let the gases out will be as low in the oven as possible, just up from the bottom. This may at first glance seem to be counterintuitive, but in fact makes perfect sense (I hope).

Hot air rises, so the hottest gases will rise to the top of the oven and as they give up their heat to the oven walls and food, they will cool and be denser compared to the newer hotter gases following. So, having the exit near the bottom allows for higher temperatures and a more even temperature distribution in the oven. Conversely, if we had the exit in the top of the oven the hot gases would rise in the oven and just keep rising straight up and out the exit flue, wasting a lot of heat.

So, put the exit flue elbow near the bottom of the oven and attach a meter or two of flue or if you are under a roof, then extend it through the roof in the usual manner and you’re nearly done!

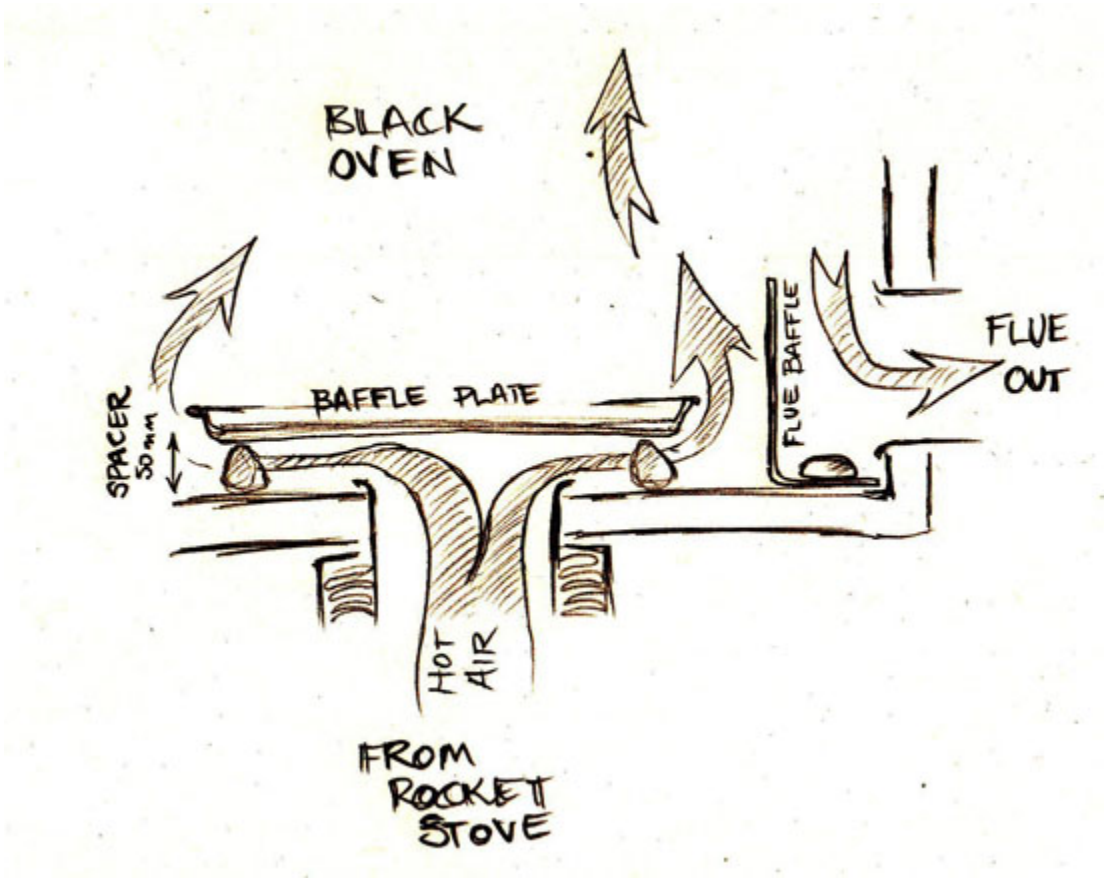
The baffle plate

Because there are hot gases rushing in from the bottom of the oven, we need a method of evening out the heat so it is not concentrated in a small area above the inlet. We do this with a baffle plate.

This is simply a piece of fireproof material that sits above the inlet and forces the gases to spread out before rising into the oven. Typically, I use an old cake tin or baking tray. I hate to say it, but usually I just space the tray off the bottom with a piece of brick or rock at each corner. Certainly, you could get excited and bend down each corner of the tray so it sits off the bottom. The important thing here is to leave a 50mm gap so as not to choke the stove. Also, you don't need a big thick steel plate as this just sucks up heat and slows the warm up of the oven.

Flue baffle

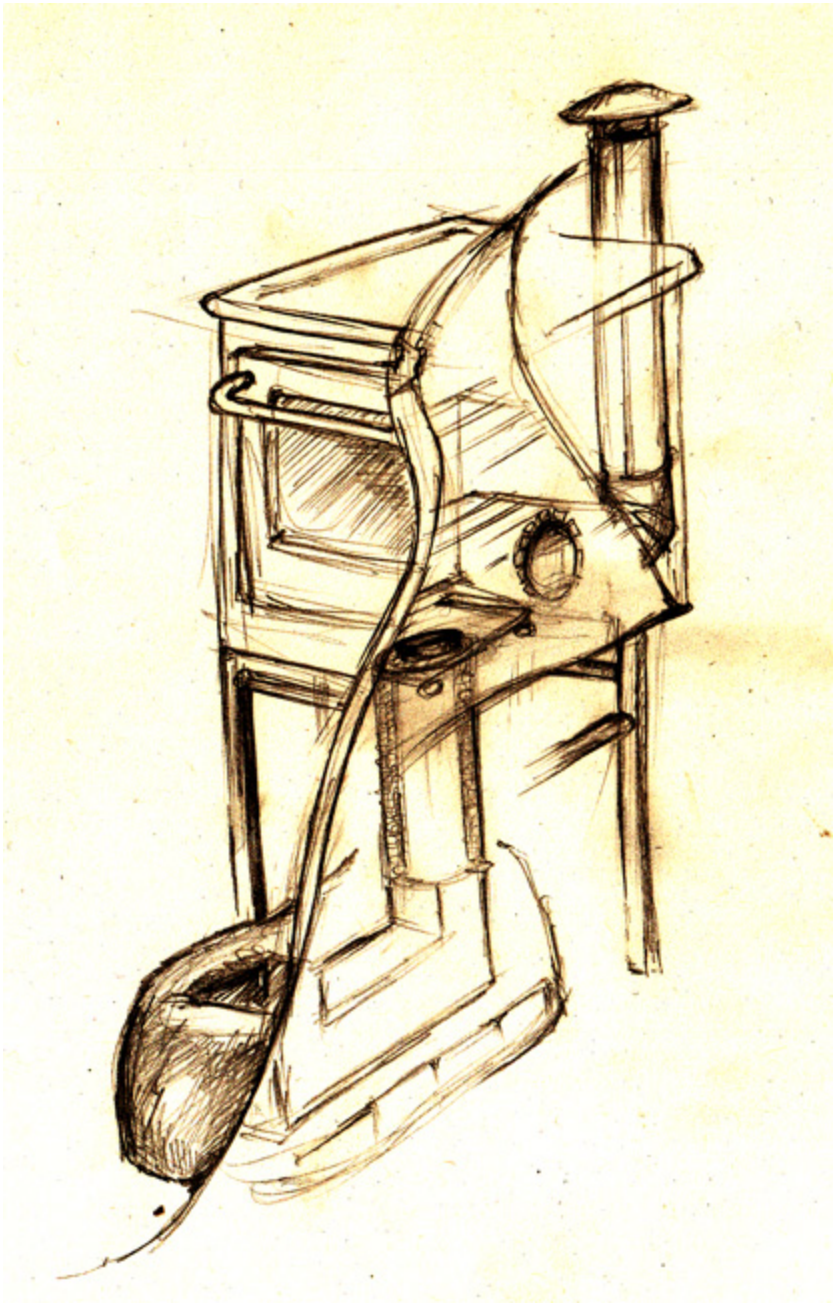
The hot gases running under the baffle plate can shortcut straight out the flue pipe so I like to put in a flue baffle. This is usually a piece of tin resting on the oven floor blocking sideways flow out the flue, but open from above.



The flue baffle stops hot gases 'shortcutting" directly to the flue.

Now, how you support the oven in place will be down to your situation.

I’ve actually used wall-mounted ovens and placed the rocket below and I’ve also built frames and benches for other applications. The important thing to note here is that you want the oven at a good useable height. The oven base should be around 800 - 900mm; any lower and you will be affecting the draw of the stove. If you are using the oven on a bench in an outdoor setting, you can also cob over the top of the oven and it will look beautiful, a hybrid of earth and recycled materials.



In using black ovens I have never had an issue with the flavour imparted by exposure to combustion gases even when the food in question was things like cakes and biscuits and of course some foods like roasts are very much enhanced by it. However, if you are interested in keeping those flavours out of your food all you need do is keep on hand some large roasting pans with lids or matched baking trays where one tray can be used as a lid.

Building a white oven

The second style of oven we can build is a white oven. We already know a black oven is one where the food is exposed to combustion gases, so you could easily guess that a white oven is one where the food is not exposed to combustion gases.

These are not as easy to build as the black oven described earlier, but I have consciously designed the building process so that the oven could be built using fairly simple tools and without much engineering skill. While the instructions seem very long it's because I've tried to keep each step to a single action, so read carefully, look at the illustrations and take your time and try and understand the instructions rather than follow them. There is no welding at all in the construction (although if you can weld and have access to a welder, then it can simplify a few of the steps needed).

Barrel safety

Modified 200 litre barrels form the heart of the oven. These are easy to come by and safe to use if you follow a few simple steps. But it is very important to be aware of the hazards.

Explosion

As we will be cutting and grinding these barrels it is vitally important that we remove any volatile fluids or materials before commencing or there is a very real possibility of the drum exploding.

Toxins

Whatever you do, don't use a drum unless you are absolutely certain you know what was in it prior. I once was invited to give an oven workshop and when I turned up, all the barrels that had been collected were ex herbicide and pesticide barrels. I don't care how well the barrel has been cleaned, don't use them. Big no no!

Make sure you know what was in your drums.

I have also been presented with barrels that contained products like organic apple juice or coconut oil. “Great!” – you might think nothing toxic there. The truth is, the insides of these barrels are usually painted to stop the contents reacting with the barrel so you will be faced with the miserable task of TOTALLY removing the paint. Otherwise as the barrel heats up it will off-gas toxic fumes into the cooking space. You can try to burn the paint off in a fire but I still don’t trust that there won’t be residues left behind. The second point is these drums will tend to have clip on lids which while they can be used are not as suitable as drums where the lids are formed onto the barrel, i.e. one piece.

Best barrels

The best and easiest barrels to get hold of are the ones that have contained mineral oils (engine, transmission, hydraulic). Yes oil burns but the contents will not ignite from grinding sparks. Also as the oil protects the inside of the drum from rust the inside of the drum will not be painted

Workshops are a good place to get the barrels especially if they have only had clean oil in them and if you ask around often they are free. If not, you can get second hand barrels from barrel recyclers. Prices vary wildly but I am currently paying $15 a barrel for good single use oil barrels. Just make sure the recyclers are aware you will be cooking inside the barrels as this will be an added incentive for them to make sure the drums haven't contained toxic gick as they certainly don't want to be held liable for potential poisoning. Finally try if you can to get similar drums. By that I mean look for drums that contained the same or similar product from the same manufacturer this will insure that critical parts like the lids will form a nice tight fit in the barrels.

Cuts

When you cut barrels, you end up with very, very sharp edges. Use gloves where possible and after each cut use a grinding blade or a sandpaper disc to smooth off the sharp edges.

Steps to safe working with barrels

1. So you have your barrel selected and you are ready to commence working on it.
2. Upend and drain it into a container, the longer the better. Save the contents and dispose of appropriately.
3. Wash with warm soapy water. I put a few litres of water in, then put in the bungs and roll the drum around for a bit.
4. Remove both bungs and drain.
5. If the container has contained product that aren't flammable or very low flammability (engine oil, veggie oil etc), then you can proceed to the final stage which is grinding the end off the barrel. If not, proceed to step 6.
6. If the drum has contained volatile products like petrol, diesel or thinners, then to make absolutely certain it won't go boom when you

grind it our next step is to fill it to the top with water. This displaces any volatile gases so there can be no explosion. After the end is off the drum the water can be siphoned out to water the garden or other uses.

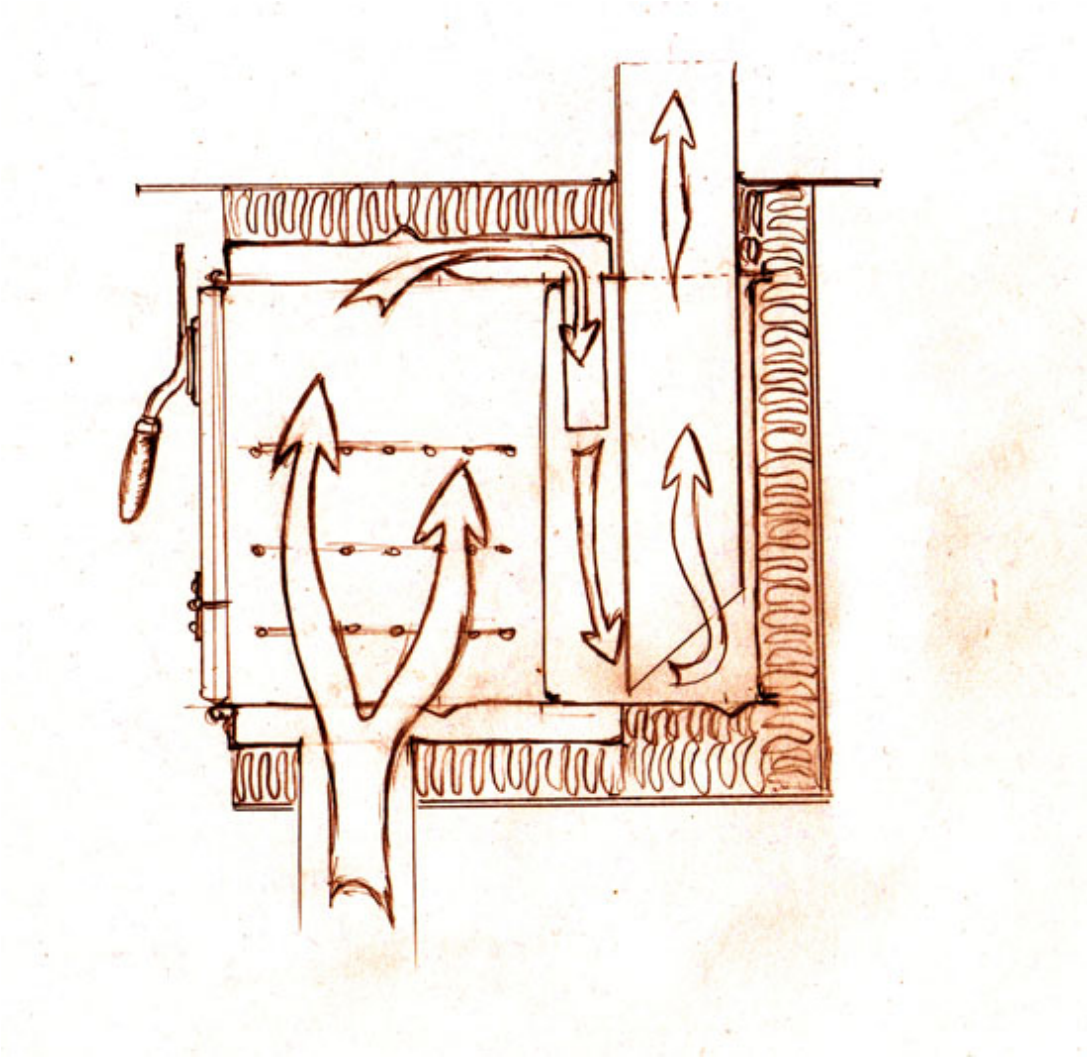
7. Once the end is off the drum the danger of explosion is eliminated, as any gases are not contained in an enclosed space. You are now ready to begin constructing your barrel oven.

How the white oven works

In our white oven design, conceptually let’s start with a single barrel with a door that is sealed against combustion gases; this is where the food will be cooked. Our challenge is to get heat from the combustion gases into this barrel, but not the gases themselves. We could merely situate a rocket stove below the barrel, and the hot gases would to some extent heat it, although most of the heat would simply escape upwards.

To make this heat transfer much more efficient, we’ll fit a section of a second barrel around the original barrel to form a chamber, to keep the hot gases around the inner barrel for longer. We’ll make the hot gases pass down the back wall of the oven, giving up even more heat to the inner barrel.

The oven will cook well enough in this configuration but to achieve maximum efficiency and safety we’ll insulate the outside of the outer barrel with fibreglass insulation, and then cover with corrugated or roofing iron to add a final water proof layer.



The gas flow path for the white oven.

Making the inner barrel

This is where we form the inner cooking barrel and also the path for the hot gases down the back wall of the oven.

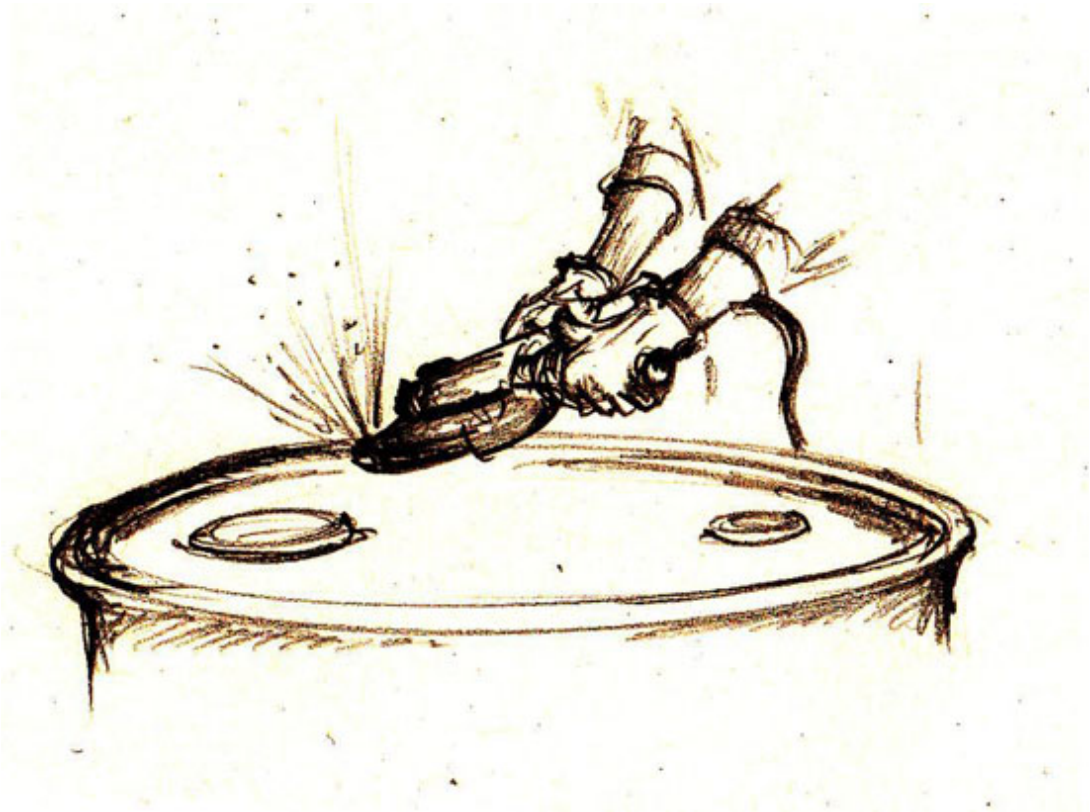
Cutting out the lids

Before you actually begin cutting your barrels you need to decide which will be your inner and outer barrel. Usually the better barrel will be the inner. Most importantly look for a nice round end without any big ‘dings’ in the lip. The best end will be your door.

Most drums will also have slight variations depending on manufacturer so its important when you cut out the lids to mark them so that they stay matched to the barrel they came from.

So to begin we need to remove the ends of our first barrel. For this, you only need a small angle grinder with a grinding wheel fitted. Of course, use all the appropriate safety gear when using any power tools. (You have been warned.)

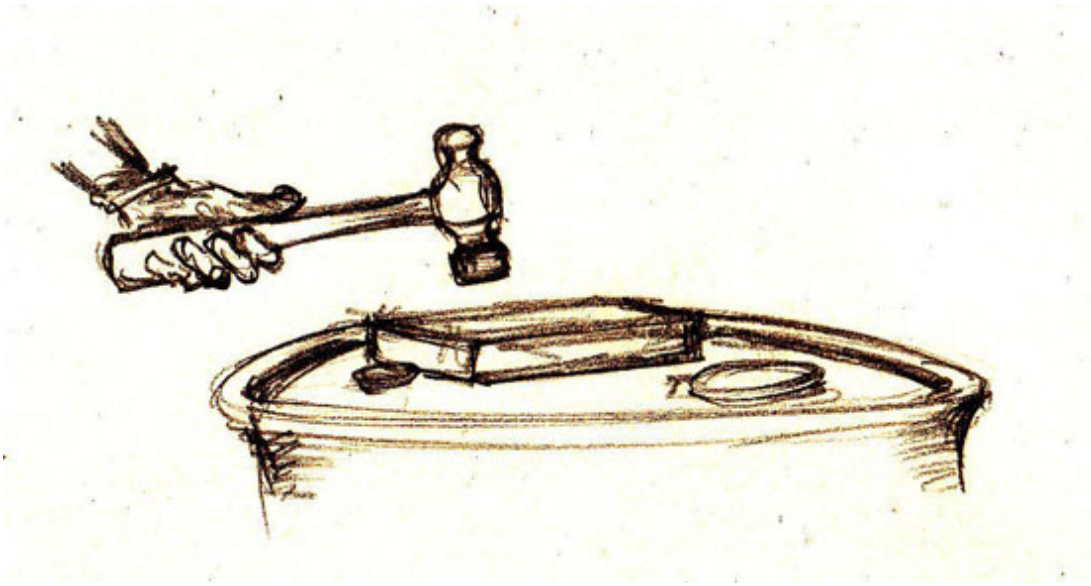
Step 1: Grind evenly all the way around on the very end of the barrel using long even strokes. Tilting the grinder in towards the lid of the barrel will ensure your remove the least amount of material. Eventually you will see a very fine line appear, often with some bluing of the metal. This indicates that the metal in the blue area is very thin. Stop grinding on this spot and move along till the line continues all the way around the drum.



Grinding out the top of the barrel

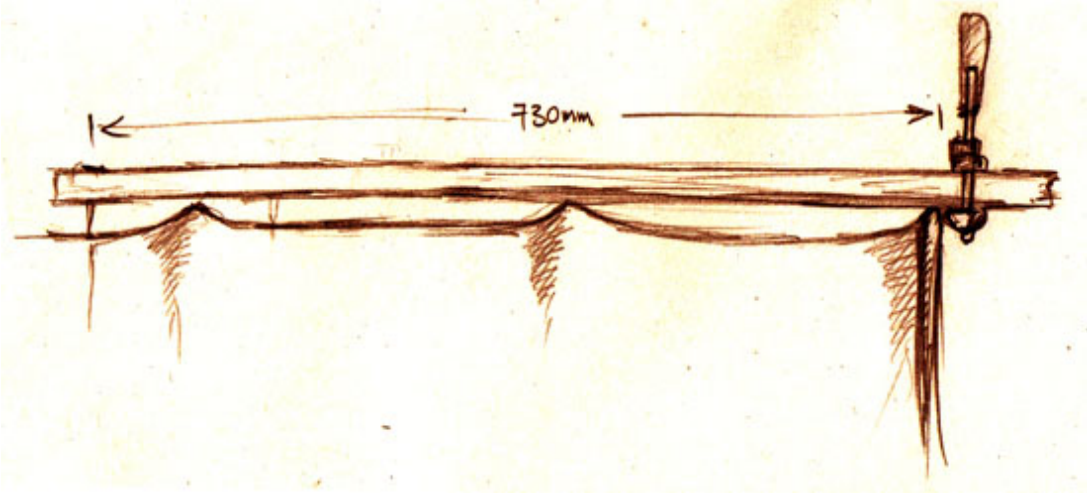
Step 2: Tap around on the inside of the end of the drum with a hammer on a block of wood so as not to dint the end and it should fall into the barrel

where it can be retrieved. If the end is a bit stuck, then note where it's not moving and give it a bit more of a grind. Do this both ends and save them.

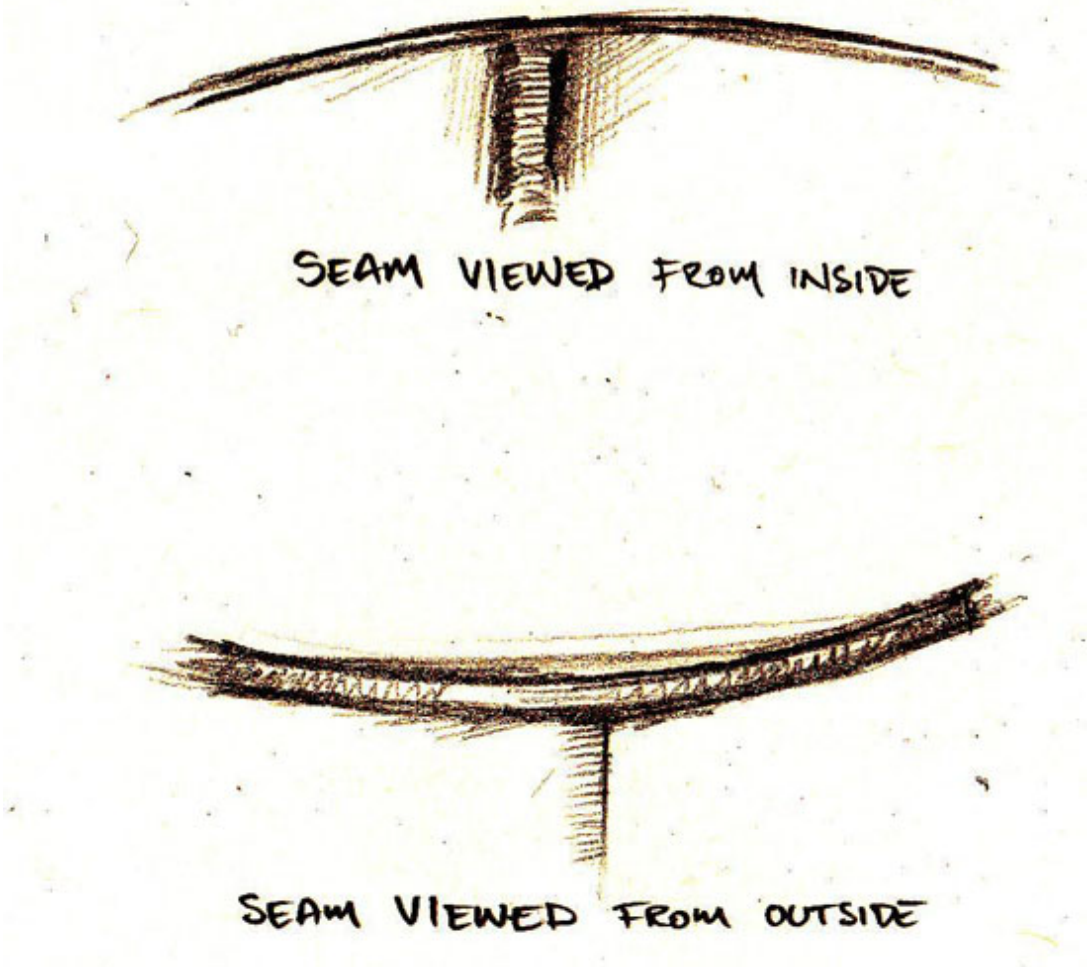


Use a block of wood to stop the top of the barrel getting dinged

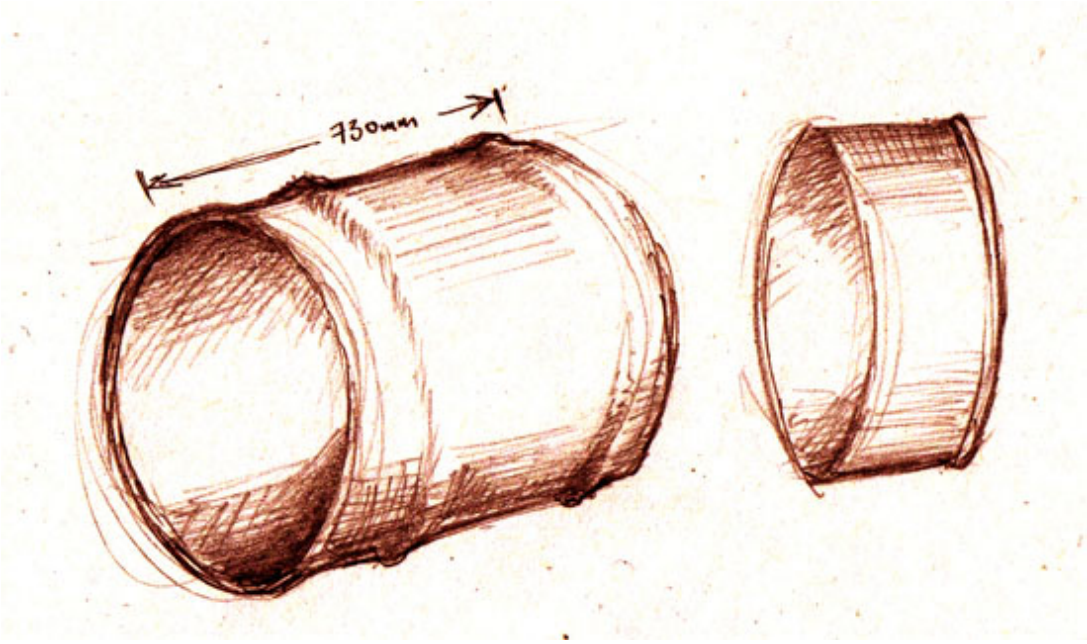
Step 3: Put one of those thin steel cutting blades on the angle grinder. (I love those things; they are so handy.) Measure 730mm from one end and mark the drum. Do this in multiple places and then join the dots so that you have a line running around the drum at 730mm. A handy trick which is more accurate and can be used each time you have to mark and cut the drum is to measure and mark once and then with an offcut of wood longer than the distance you need to measure, hammer a nail in one end. You then line the nail up with the mark on the barrel and with a small clamp or a set of vice grips resting on the lip of the barrel clamp the piece of wood. Then just drag the piece of wood with the nail in it around the circumference of the drum keeping it at 90 degrees to the lip and scratching a line in the paint.



Simple jig to draw a straight line around the barrel.



Step 4: Once the mark is made you can cut the drum along the scored line and you will end up with two pieces of barrel one 730mm long and one approx 150mm long. Put aside the shorter piece for later.

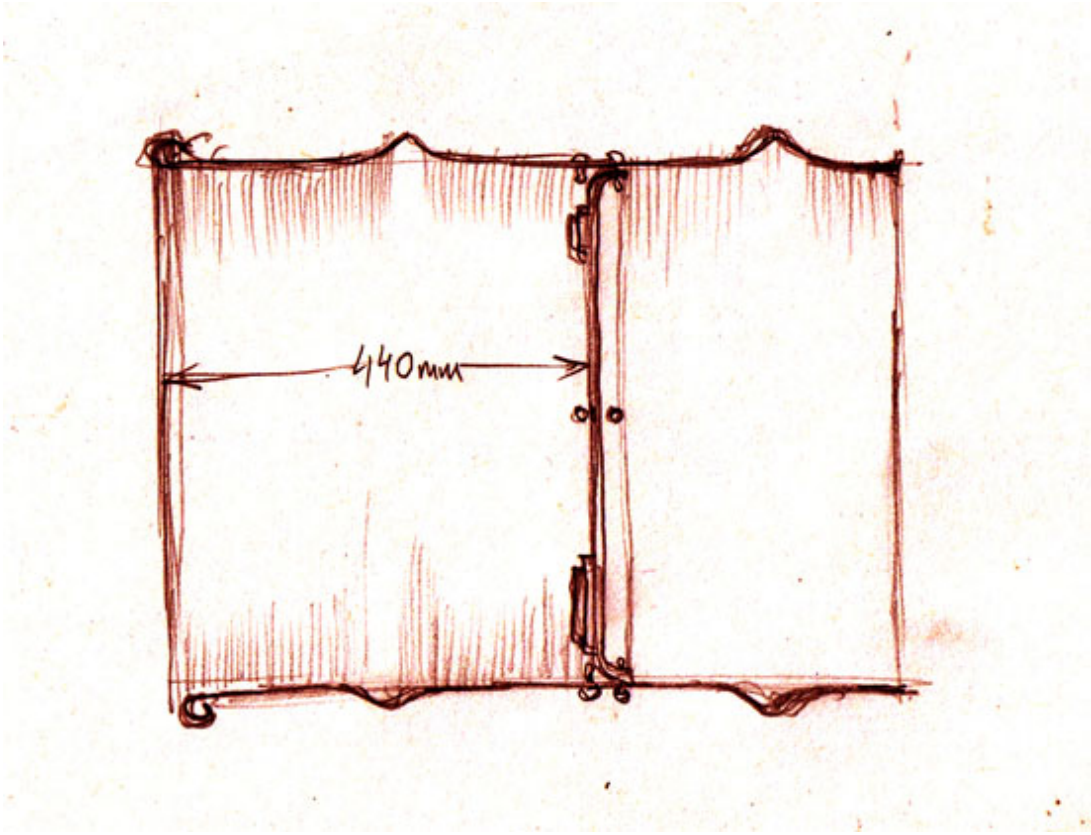


The major sections of the inner barrel

Step 5: Grab your 730mm barrel section, and from the end of the section with a lip, measure 440mm down the outside of the barrel at the 12 o'clock position and make a mark. Do this in four equally spaced points (12, 3, 6 & 9 o'clock) and drill holes to suit the pop rivets you have. Coming from the outside of the barrel, place a pop rivet in each of these holes and rivet them in place. Take the barrel lid with the two bungs, and with the bigger bung at the 6 o'clock position, slide it into the barrel from the end *without* the lip. Tap it evenly into place and snugly against the pop rivets which act as positioning stops. We want to rivet the lid in place, so measure back 10mm from each pop rivet and drill and pop rivet again hopefully through the flange of the lid. You can try and tap the lid in and pop rivet in place without the stopping rivets but there is usually a lot of comedy in trying to line everything up.

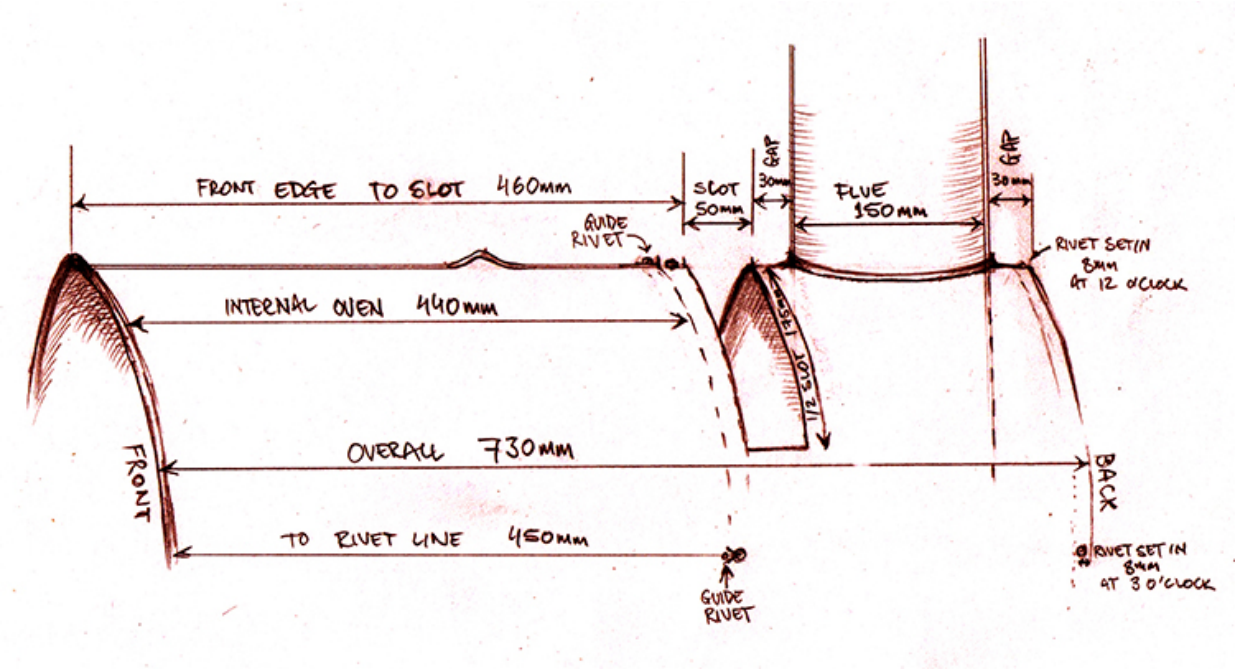
Look at the lid you have just installed and tap any gaps you see out against the barrel for a snug fit.

Unscrew both the small and large bungs and remove the rubber ‘o’ rings as these will burn and make lots of toxic smoke when the oven is fired up the first time. Put the bungs back in place but screw them in from the inner side, this will allow you to remove them from inside the oven and facilitate sucking ash out with a vacuum cleaner rather than removing the access panel and insulation of the outer skin.



The inner barrel showing where we measure, mark and drill to hold the back wall of the oven in place

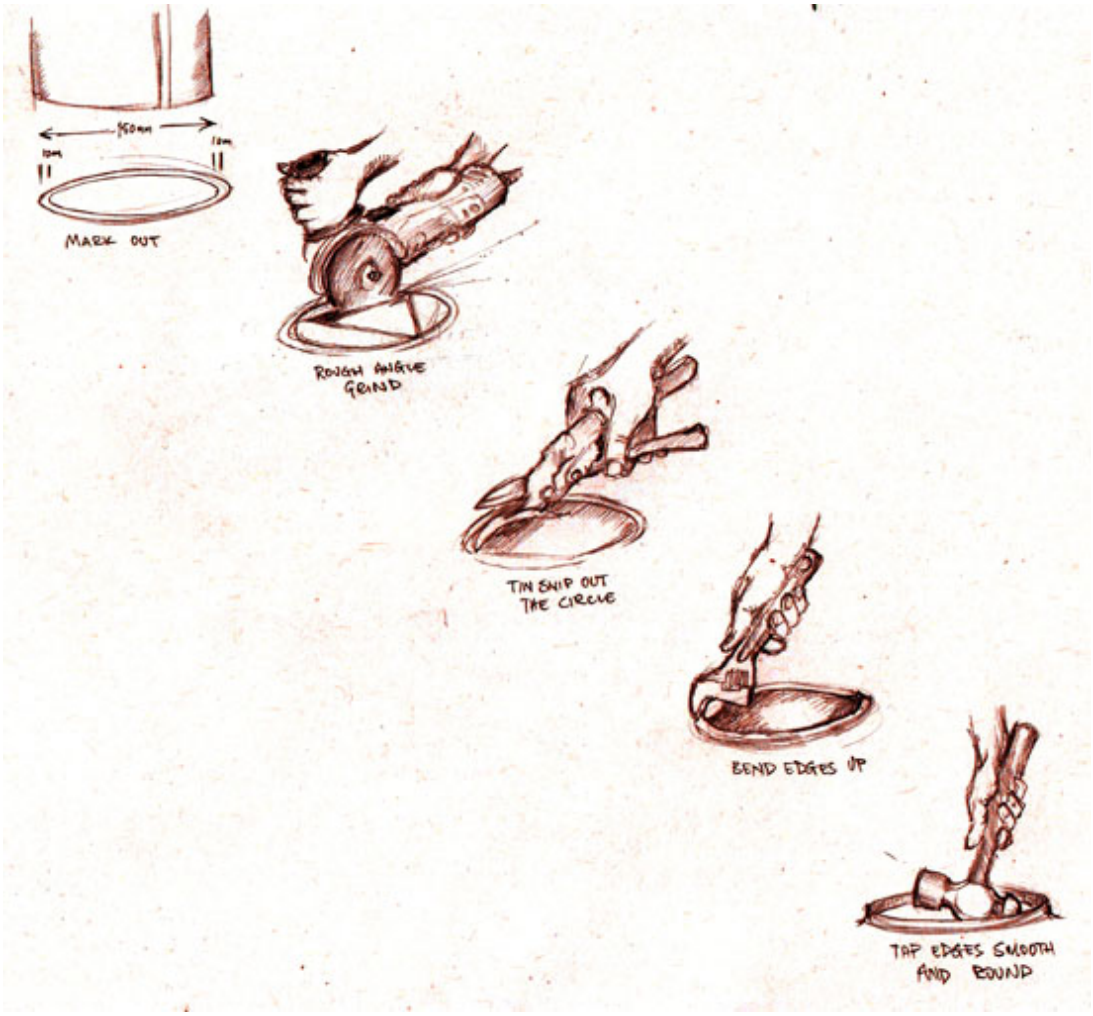
Step 6: From the end of the barrel without the lip, follow the 12 o’clock seam till it meets the flange of the lid you have already pop riveted in. Drill through the seam right beside the flange of the lip. Measure 175mm clockwise and counterclockwise from this hole and drill beside the flange of the lid for a total of 350mm. On the outside of the barrel connect the dots to form a line. Now measure back 50mm towards the cut end of the barrel and draw a 350mm line parallel to the first. Joint the ends of the lines so you have a rectangle 350mm long by 50mm wide. **Don't cut it out yet** – because leaving it in place helps stabilise the barrel in the next step.



Dimensions

Step 7: We now need to cut the hole for the hot gases to get out of the oven through the skin of the inner barrel. At the 12 0'clock position mark back 30mm from the 350mm x 50mm rectangle you have drawn previously in step 6. Use a piece of your chosen flue pipe (150mm) centered on the 12 o'clock line and with one edge on the just marked position trace the outline of the flue. Mark a line 10mm inside the first circular line and cut out the area inside this circle. This can be done by using the very tip of the thin cut-off blade and tracing around the circle. Don't try to grind through in one place, but continue going around until the circle is completely cut away. You can also use tin snips but you will need a left or right handed pair. No, it's not a joke! The coloured handles aren't for decoration but to tell you which way they cut. Red handles are for right handed or clockwise cuts and green are for left handed counterclockwise cuts. Both red and green will also do straight cuts. Yellow handles are for straight cuts and very slight curves.

Here's what you do. Use your angle grinder but cut out a rough hole (a triangle is easiest as it's three overlapping straight cuts) so that you can get your snips in. Start cutting with your snips spiralling outwards in the correct rotation for the snips. After you have cut your hole, get a small shifter or pliers, and moving all the way around the inside of the circle, bend the lip up a little bit.



Making a neat fitting flue opening

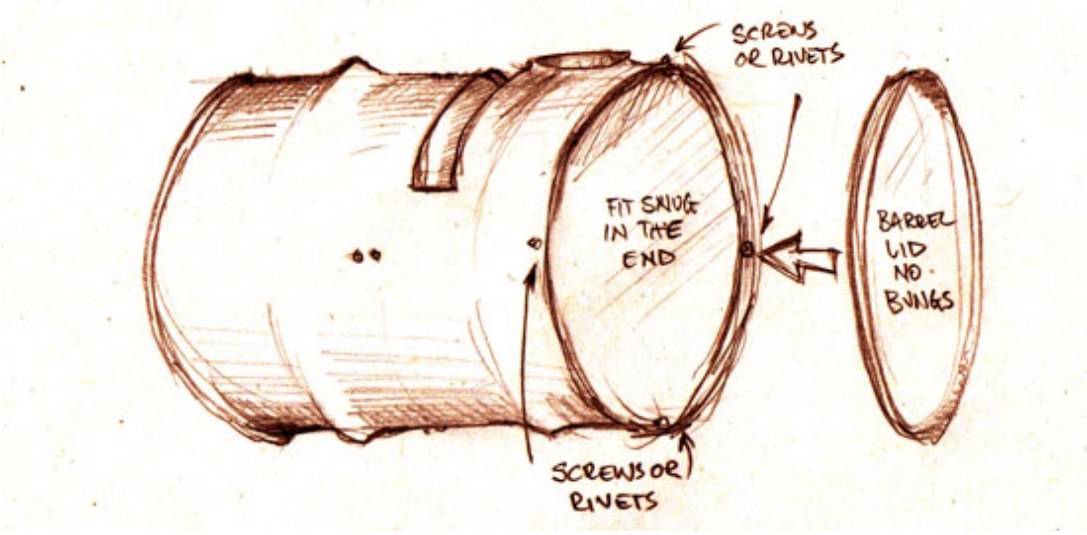
Step 8: You can then use a small ball peen hammer and bell the lip upwards by tapping and moving in a circle until such time as the lip is at 90 degrees to the surface of the drum, and your chosen flue pipe slides in with a nice tight fit. This will take some time, but be patient and it will look very neat and hold the flue steady. Don't install the flue pipe at this stage.

Step 9: Using your angle grinder and cut off wheel, cut out the 350mm x 50mm rectangle you drew earlier. This will form the slot for the hot gases to pass down the back of the oven.

Step 10: Cut the end of the flue pipe at 45 degrees and then slide that end into place till it touches the bottom of the oven. Make sure the cutaway faces

towards the back of the oven. Tap the lip you formed in step 7 back against the flue pipe to for a nice tight fit.

Step 11: It's important to reserve the remaining lid for the oven door to get the best possible fit, so you should now grind out the lids of the remaining barrel, and use the lid without bungs from the new barrel. Tap it into the cut end of the inner barrel so that the flange of the lid sits flush with the cut end of the barrel. Either tek screw or bolt this in place so it can be more easily removed for cleaning but be warned with use the two pieces tend to 'grow' together.



Apart from the door and racks that's the inner barrel done.

Making the outer barrel

This is where we make the outer barrel which will force the hot gases to flow around the inner barrel. It will create a 50mm gap which is large enough that it won't restrict gas flow and yet still make the hot gases 'scrub' against the inner barrel and give up heat.

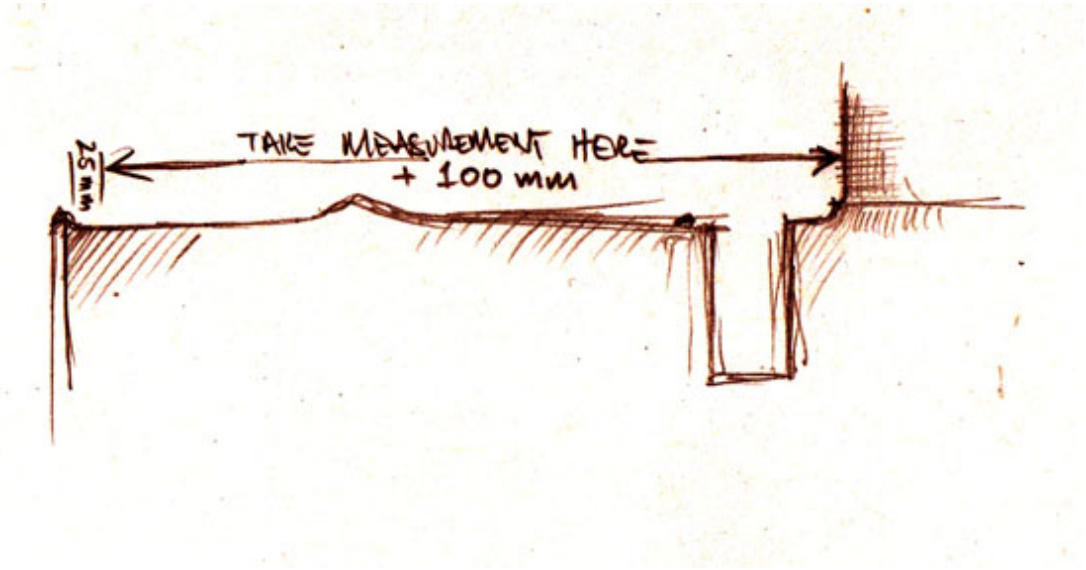
Step 1: Take the remaining barrel which you ground the ends out of in the previous section.

Step 2: Cut off the hoop on one end of the barrel and put aside. The hoops are simply the name I have given to the rolled edges on the top and bottom

of the barrel.

Because there is a lot of small variations in barrels, and the relative accuracy or otherwise of the builder, it is difficult to give an exact measurement for cutting the outer barrel. Luckily the inner barrel from the previous chapter is pretty much finished and so in the next step we are measuring the inner barrel.

Step 3: At the 12 o'clock position on the **inner barrel** (yes the one you finished in the previous chapter), starting 25mm in from the underside of the lip, measure all the way back to the flue pipe and then add a further 100mm. The 25mm is simply the distance the outer barrel will sit back from the door end of the inner barrel and the 100mm is to allow 50mm tabs on each end of the outer barrel.



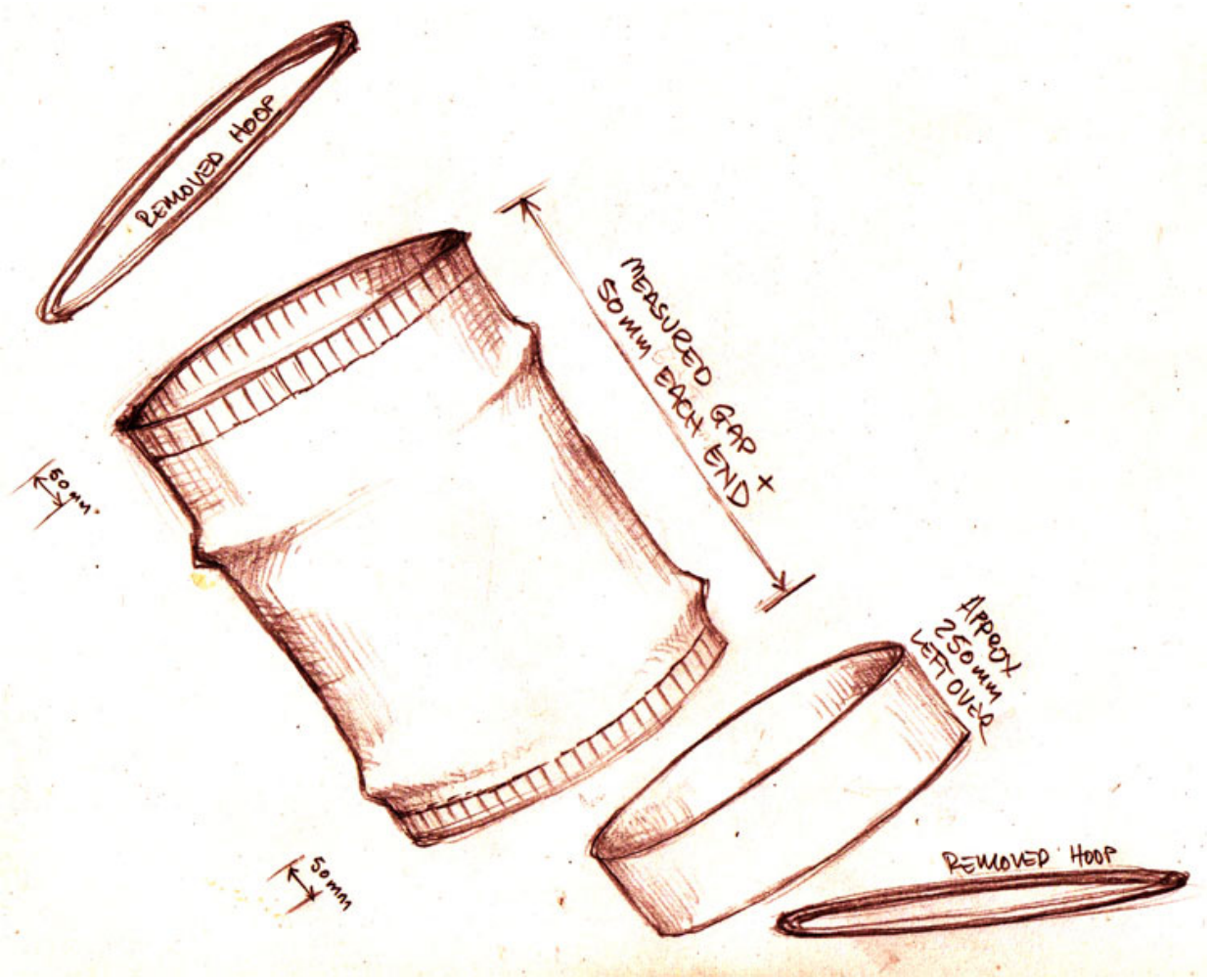
Measuring the inner barrel.

Step 4: Take the measurement from step 3 and mark on the **outer** barrel measuring down from the cut edge and mark a line all the way around the barrel. Cut at this line. Now draw a line 50mm in from both ends around the circumference.

As mentioned earlier, one method I use to achieve this is to measure and cut a cardboard square 50mm long and holding it flush with the end of the barrel

and with a pen against the barrel on the other end draw a line as you drag the cardboard around.

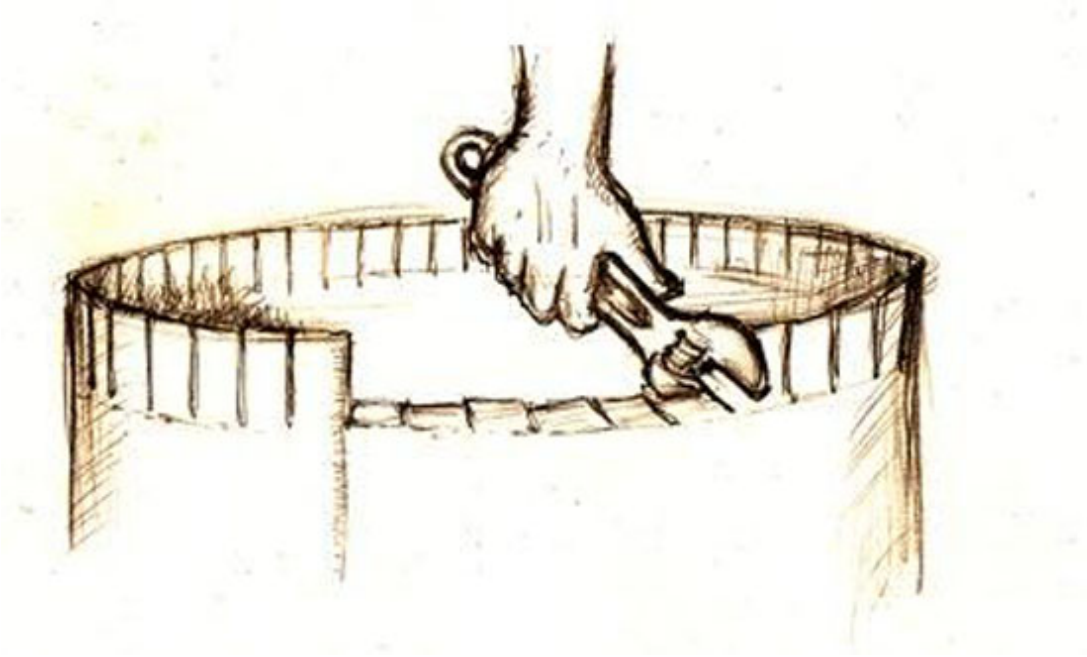
Step 5: Find the seam in the barrel and using this as your starting point mark a line every 25mm. Do this both ends.



All the pieces of the outer barrel, with tabs marked

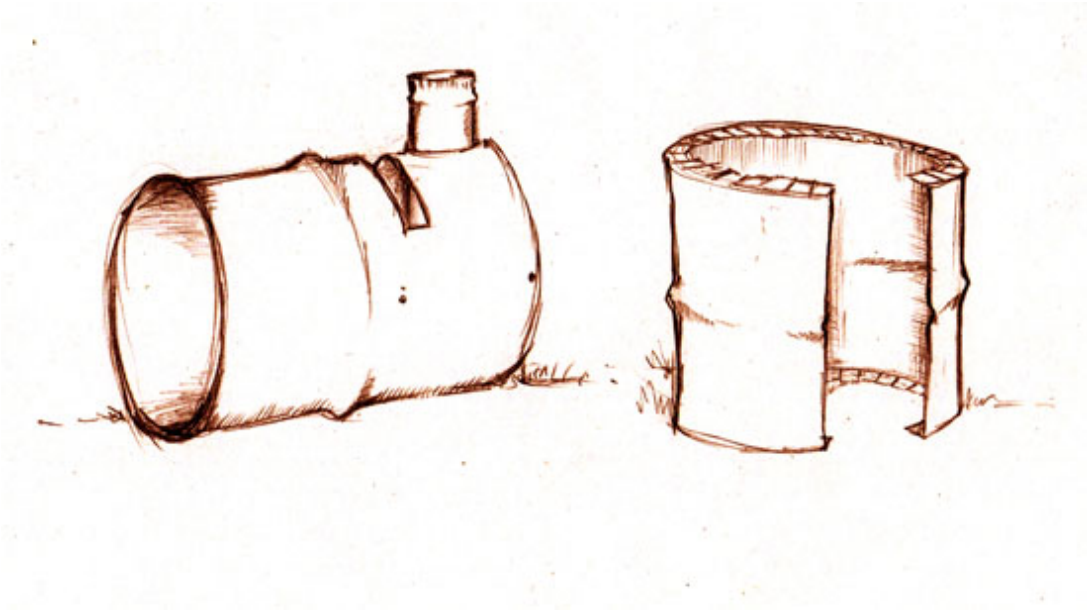
Step 6: Using tin snips or the angle grinder cut from the edge down to the 50mm line, following the marks you made with your cardboard template. In this instance I prefer the tin snips as you will get a neater result. Also if you start in one place and proceed all the way round in one direction, when you bend the tabs in the next step, they will lay down very neatly, each tab tucked slightly behind the next. Do this both ends.

Step 7: Bend tabs inwards at 90 degrees both ends.



Bending the tabs down. You can also use a hammer.

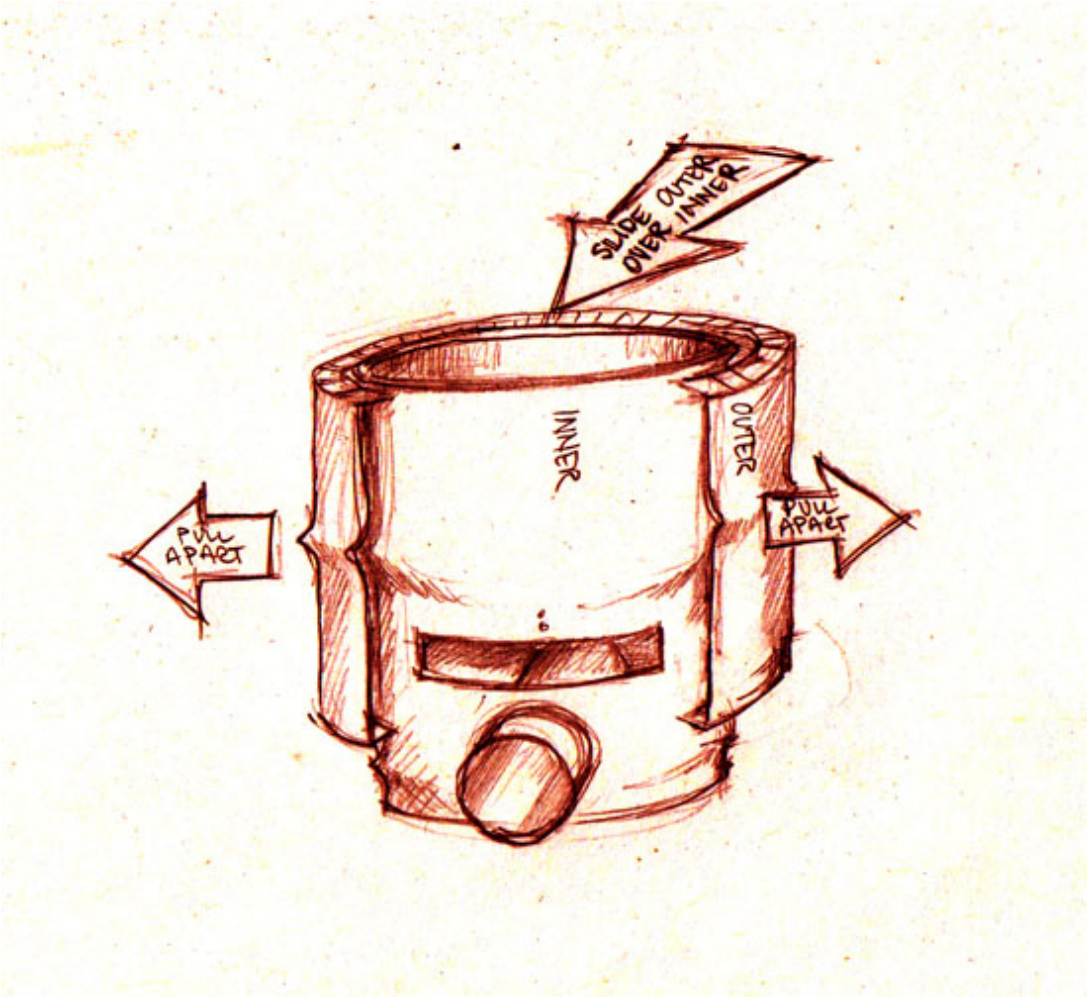
Step 8: Using the welded seam as a guide, cut along the line so the drum is split lengthwise. We'll refer to the centre of the gap we've just cut as our 12 o'clock position on the outer barrel.



The inner (left) and outer (right) barrels

Step 9: For the next step you will need a helper. Flex the split drum apart – but not so much that it is permanently bent – then slide the front of the inner

barrel inside till the end of the outer barrel is inline with the edge of the flue pipe.

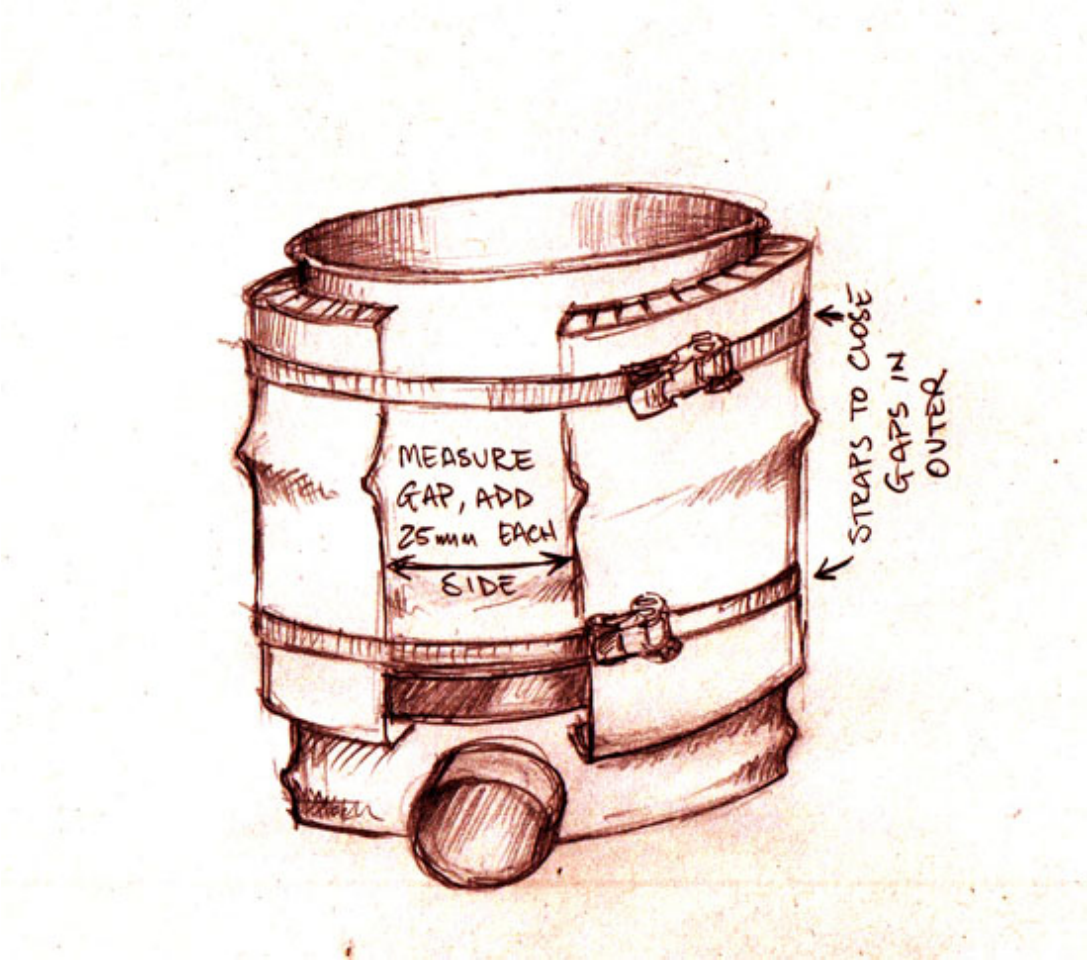


Nesting the two barrels together.

Closing up the outer barrel

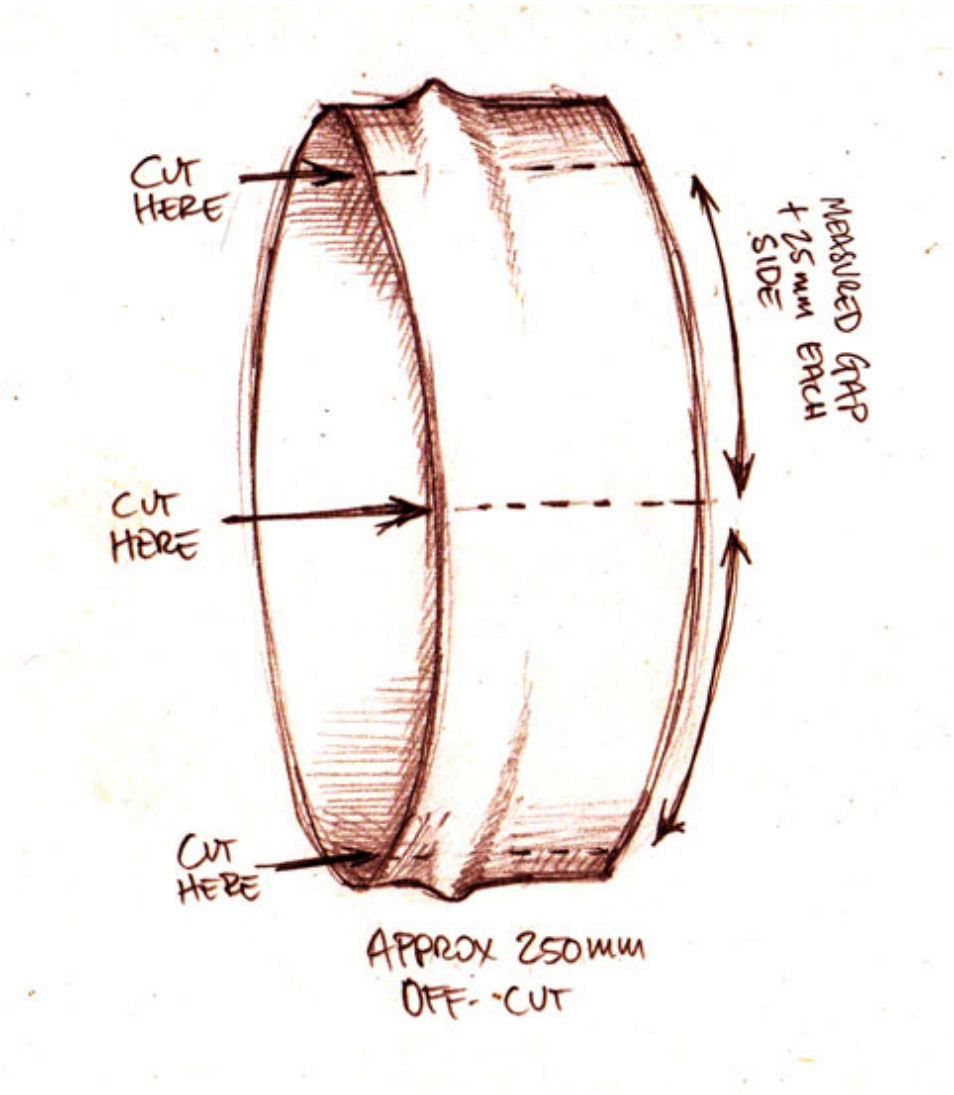
The next step is to close off the gaps between the inner and outer barrels as well as the gaps at the top of the outer barrel so we have a fairly well sealed pathway for the gases to travel around the inner barrel. The slight gaps you will have between the tabs and the barrel are not of a concern because all these areas will be covered in a layer of fibreglass insulation later in the installation which will help seal off any gas leaks.

Step 1: Loop two ratchet straps around the outer drum, and tighten till the outer barrel is a snug fit onto the inner. Alternatively, if you are handy with knots and ropes, tie two ropes in a truckie's hitch around the barrel. Tapping a few times with the flat of your hand will help it settle into place.



Holding the outer barrel on with ratchet straps

Step 2: Measure across the gap formed by the split outer barrel and add 25mm for overlap on each side. Take this measurement and mark it onto the outside of the barrel section you have left over from making the **inner** oven barrel and cut it out. You will probably need to make three of these to patch the gap.

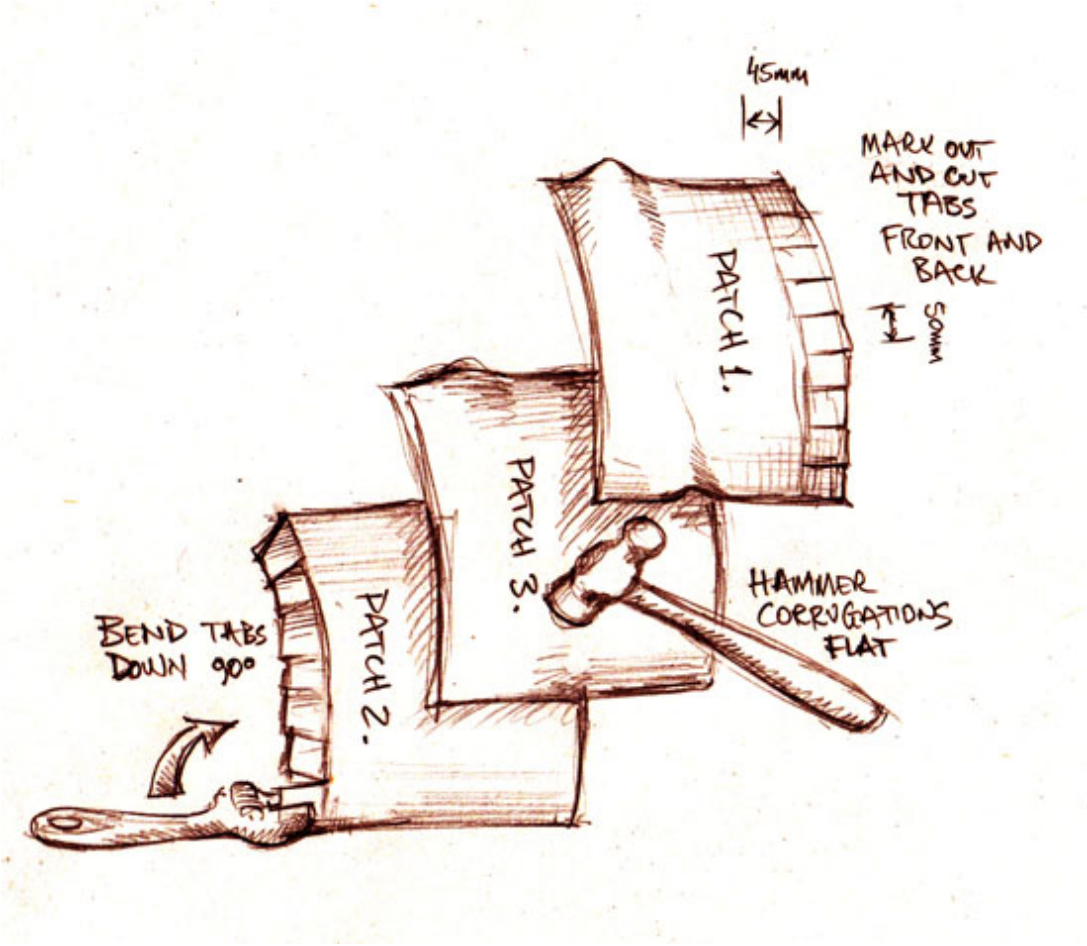


Using a barrel offcut to make the sealing plates to close the outer barrel up

Step 3: Take your cutout panel and draw a line 45mm in from one of the curved ends. Only do this for one end of the plate. The 45mm dimension will eventually give us tabs that, when bent down, close off the gap between the inner and outer barrels.

Step 4: Mark lines at 50mm spacings from the end of the plate down to the 50mm line.

Step 5: Bend all the tabs down to 90 degrees.

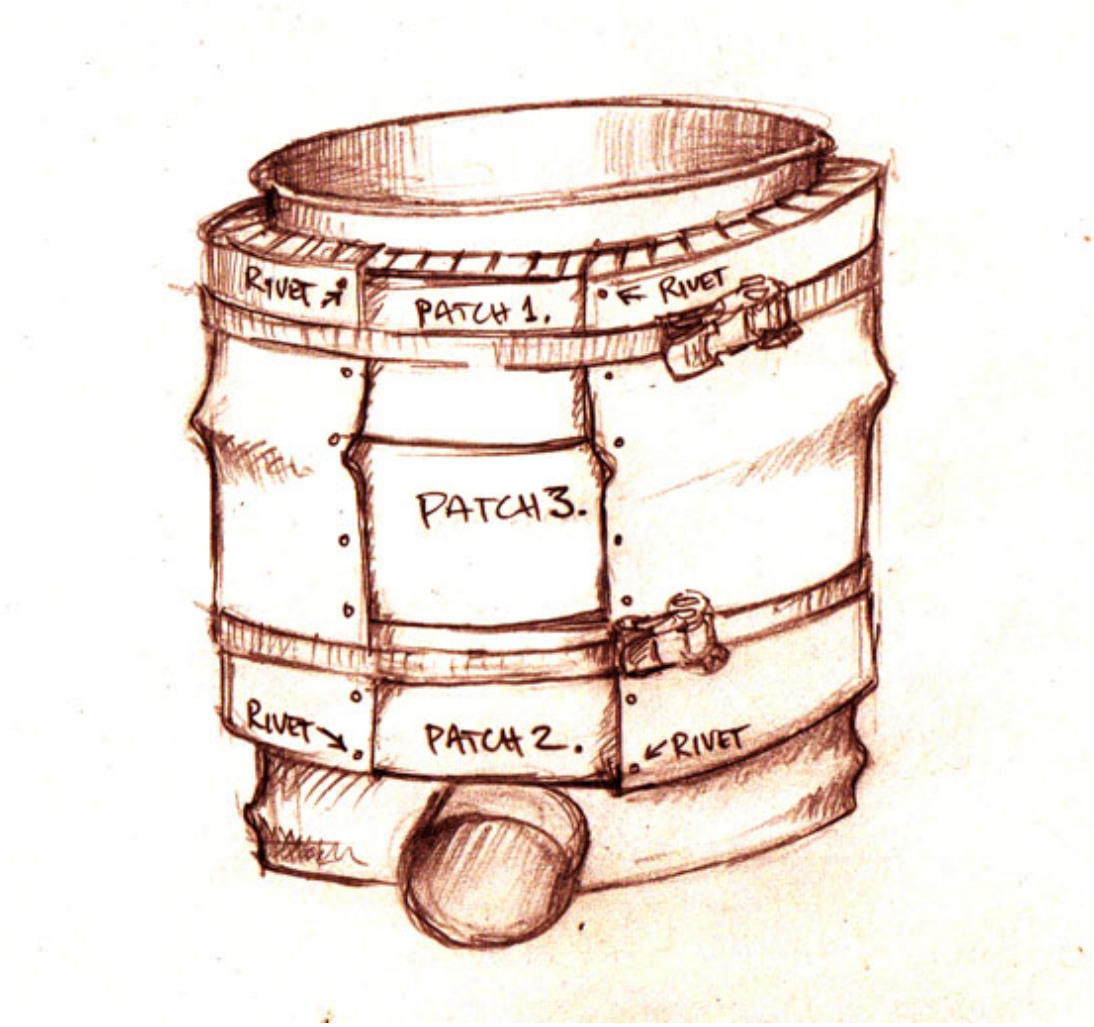


Making the end plates to seal the outer barrel

Step 6: You will now almost certainly come up against the issue that the drums, and therefore the patching plates, have large ribs formed in them and that they will stop the plate(s) from sitting flush. On a flat hard surface simply flatten those sections of rib that sit up and then slide them into the gap and lift up against the underside of the outer barrel. A piece of wood comes in handy to lever upwards. You can now drill and pop rivet in place. Leave the untabbed end half of the patch plate unriveted.

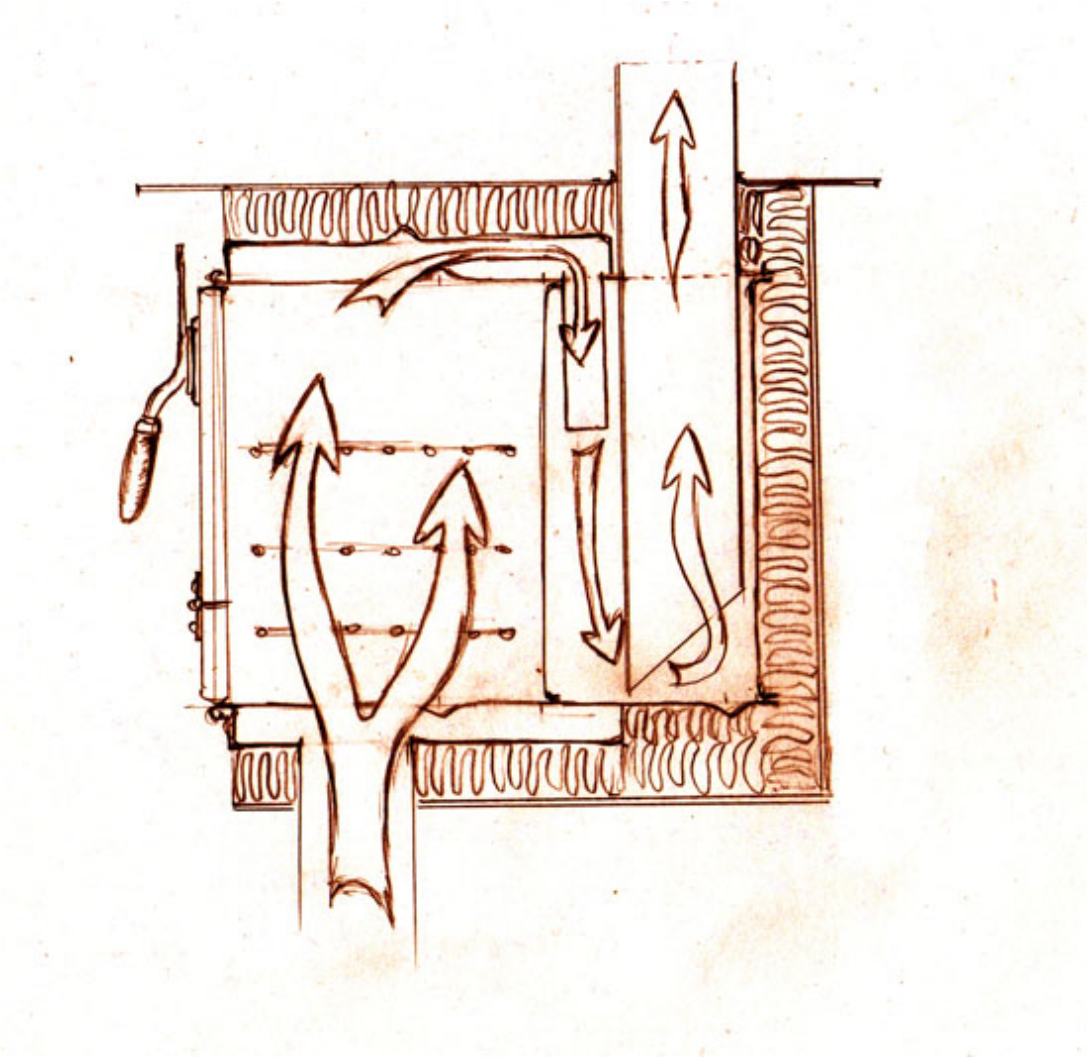
Step 7: Repeat steps 2, 3, 4 and 5 for the other end and drill and pop rivet in place.

Step 8: Cut another plate to fill the gap between the two end plates with a little overlap and then slide into place between the outer barrel and the two patch plates and pop rivet.



The two nested barrels showing the positions of the closing off plates. Note the cut outs for the ribs.

Step 9: Mark a line along the outer barrel at the 6 o'clock position and measure back along this line from the front edge of the outer barrel 207mm. This is the centre of the opening for the heat riser. Mark the dimensions of the heat riser opening on the barrel using your mark at 207mm as the centre and cut out. Remember the opening size is that of the **inside** dimensions of the heat riser not the outside.



Heat path around your white oven

The shelves

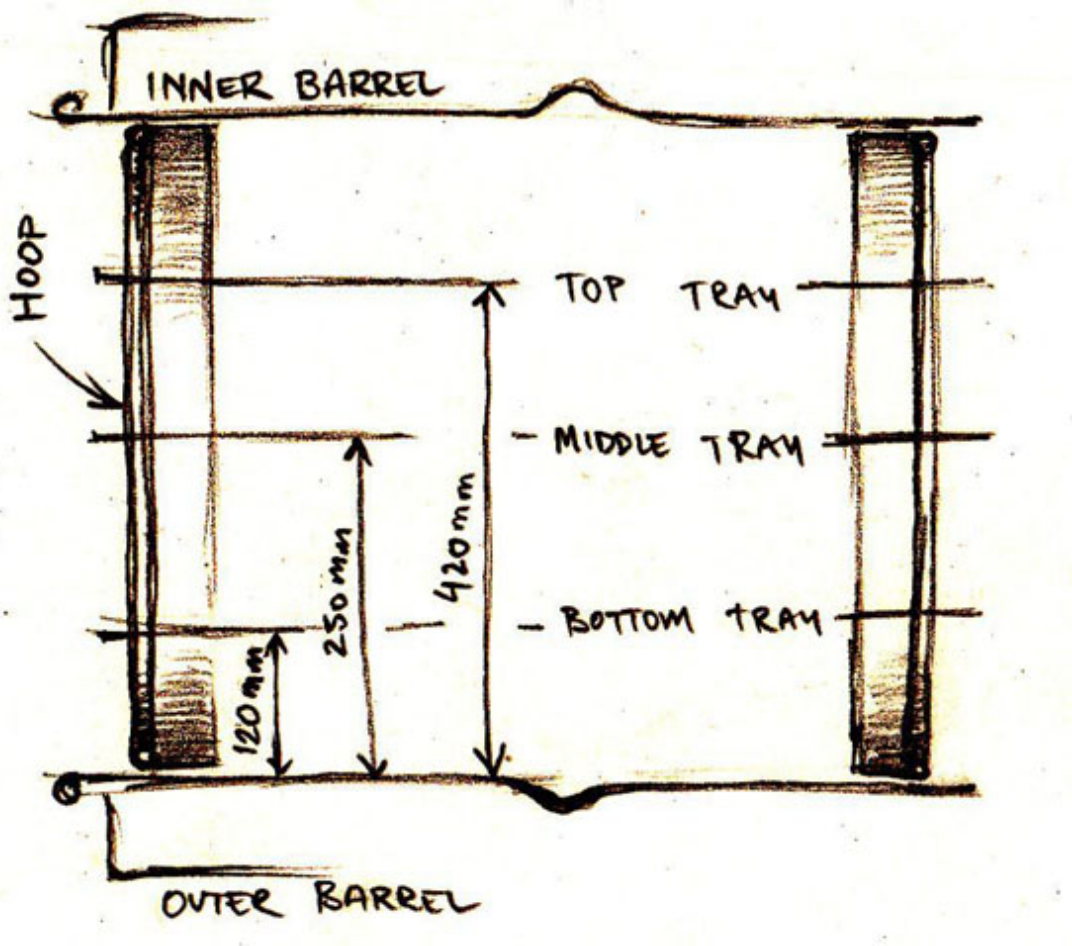
Making shelving without access to a welder can be a little challenging but nothing that can’t be overcome with a little ingenuity and a bit of scrounging.

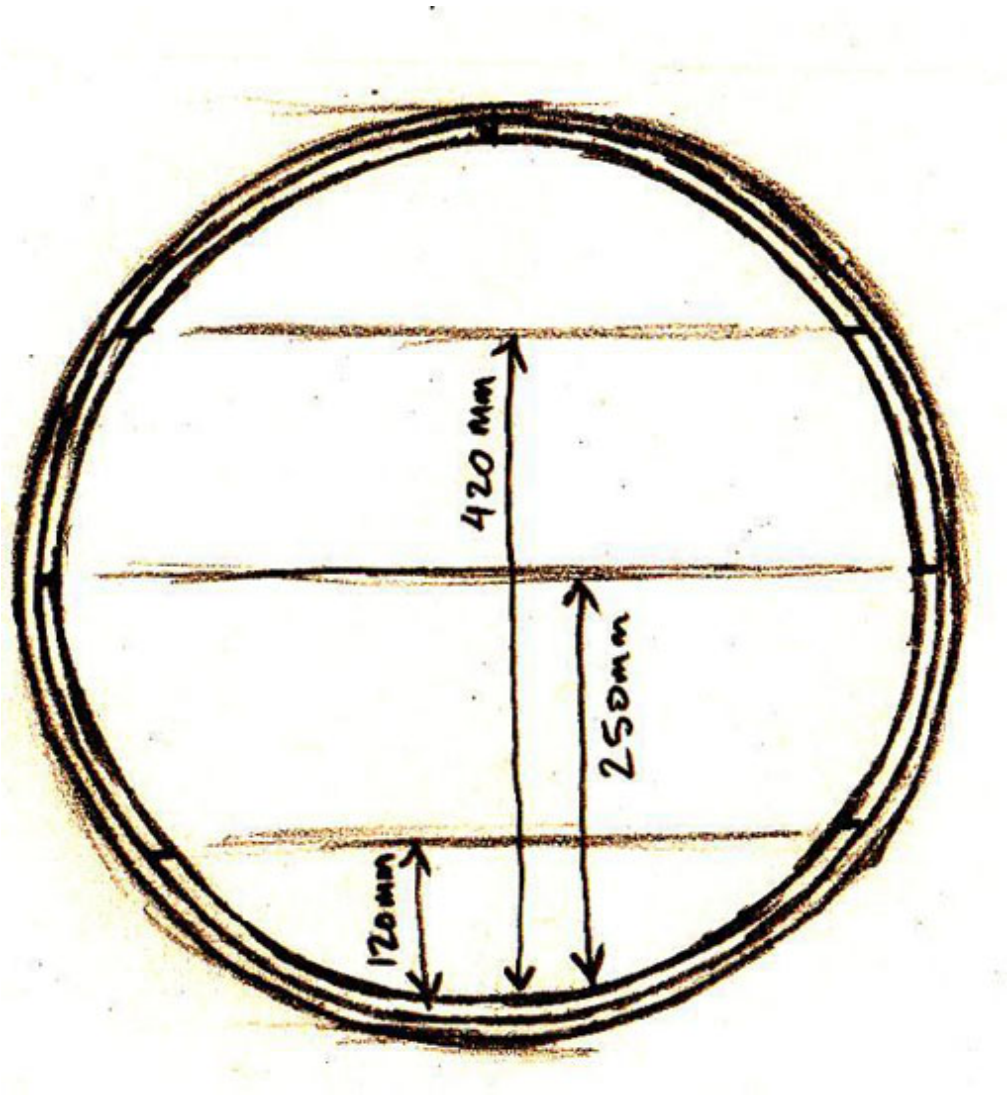
I usually build an oven with three shelves knowing that at any given time only two will be in use unless the pans and whatever you are cooking have a low profile. The circular shape of the oven is great for even distribution of heat but it means that if you are going to have shelves spanning from one side of the oven to the other they will be different sizes. What I usually do is make the top and bottom shelves the same size so they are interchangeable.

The centre shelf is so obviously bigger than the other two that you can’t mix them up. This arrangement gives us the maximum usable oven space.

Of course theoretically you can add as many shelf supports as you want for maximum flexibility.

The shelves are usually some scrap steel mesh. Use either mild or stainless steel. The usual options are old oven shelves or even steel fridge shelves if you can find them, but don’t use steel plate as it will seriously affect the performance of the oven. Joel, the producer of the beautiful drawings in this book, makes nice sturdy shelf supports using light 90 deg angle iron or aluminium which can be found as scrap or new in most hardware stores. Profiles of at least 20mm each edge and up can be used. You will need enough for six shelf supports, two each shelf, approx 400mm long. Once the oven is installed on its base, measure up the back wall and mark the positions of the shelves as shown in the drawing. Use a small level to extend the marks across the back and along the sides of the oven. Drill two or three equally spaced holes in each angle and, holding in place on the shelf lines, mark through the holes onto the inner barrel and drill these holes out. The bottom and middle shelves can now be riveted in place. Because of the inwards curve of the top shelf the angle iron here will have to be squashed in so that the ledge formed by the angle is horizontal.


INNER BARREL
HOOP
TOP TRAY
MIDDLE TRAY
BOTTOM TRAY
420mm
250mm
120mm
OUTER BARREL

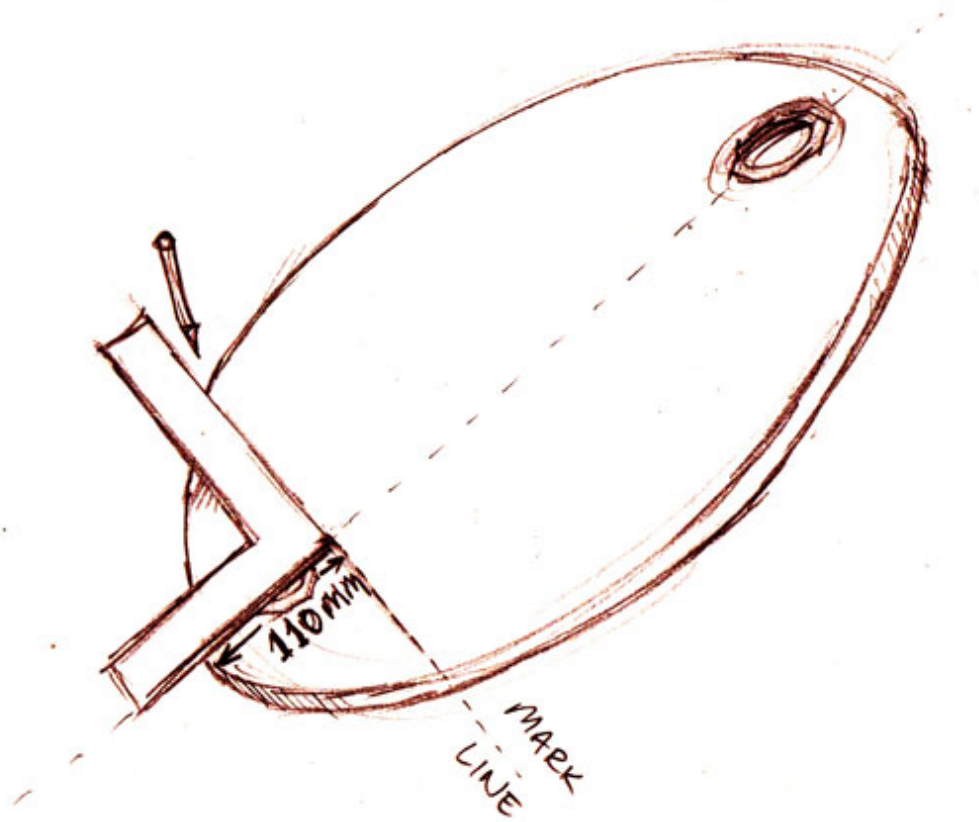


The relative positions of the shelves.

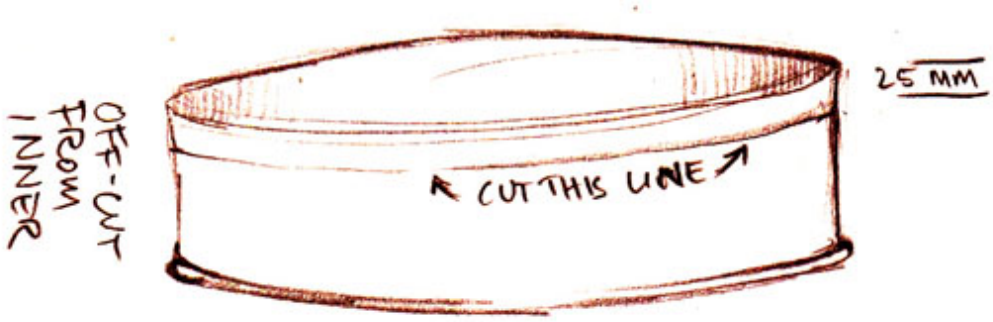
The door

To keep as much heat as possible in the oven door is insulated. We do this by sandwiching some fibreglass batt between the two barrel lids.

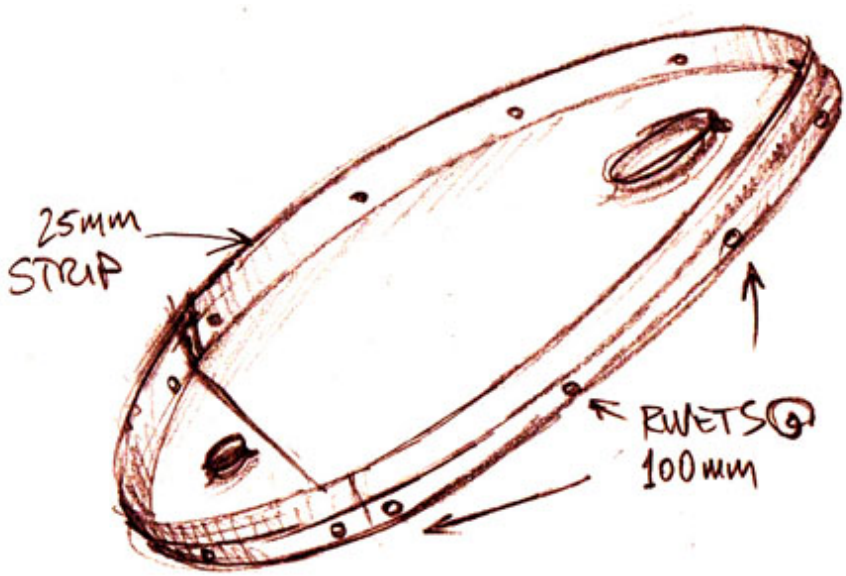
Step 1: From all the barrel bits you have left over you should have a lid with bungs in it, and this is your outer door skin. Take this lid and, on the internal (unpainted) side, draw a line through the center of the two bung holes, imagining the big bung is at 12 o'clock and the little at 6. Now, measure up 110mm from the outer edge of the lid at the 6 o'clock position and using a set square or some other right angle draw a line across the lid.



Step 2: Using the off-cut from the outer barrel, cut a 25mm wide hoop off the end without a lip and lay this inside the lip of the outer door skin from the previous step. Note that you will have to cut out a section of the hoop as it will not fit otherwise but make it so it is as little as possible.

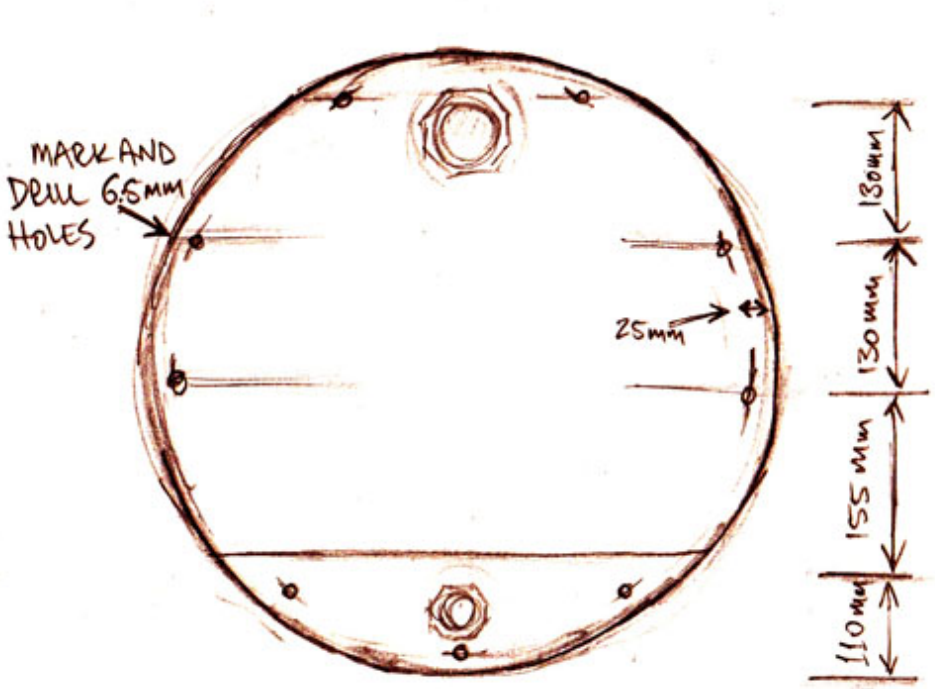


Step 3: Align the cut in the hoop with the 12 o'clock position on the lid. Starting at the cut end of the hoop clamp, drill and pop rivet the hoop to the inside of the lid approximately every 100mm but make sure you have a rivet in place just above and just below the 110mm line on both ends. This is because we are going to cut this line later and we want the ends of the hoop to be secure and stable either side of the cut.

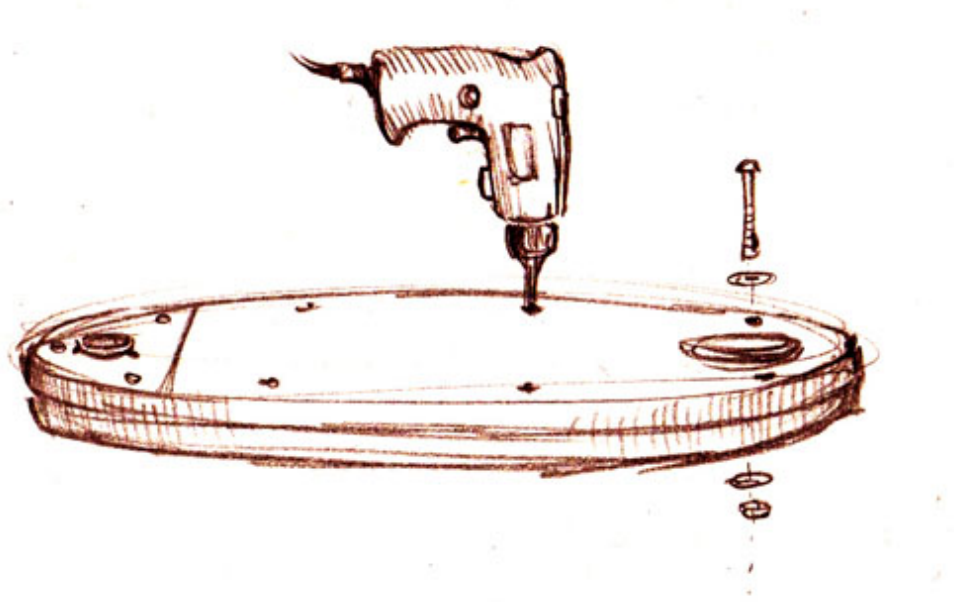


Step 4: Draw a line parallel to the 110mm line 155mm above it, and another 130mm above that line, and then 130mm above that line. Measure in 25mm from the ends of all these lines and mark.

We also want to stabilise the bottom section of the door so below the 110mm line we will make three additional marks 25mm in from the lid edge. The first will be at the bottom of the lid in the 6 o'clock position and the other two 25mm down from the 110mm line.

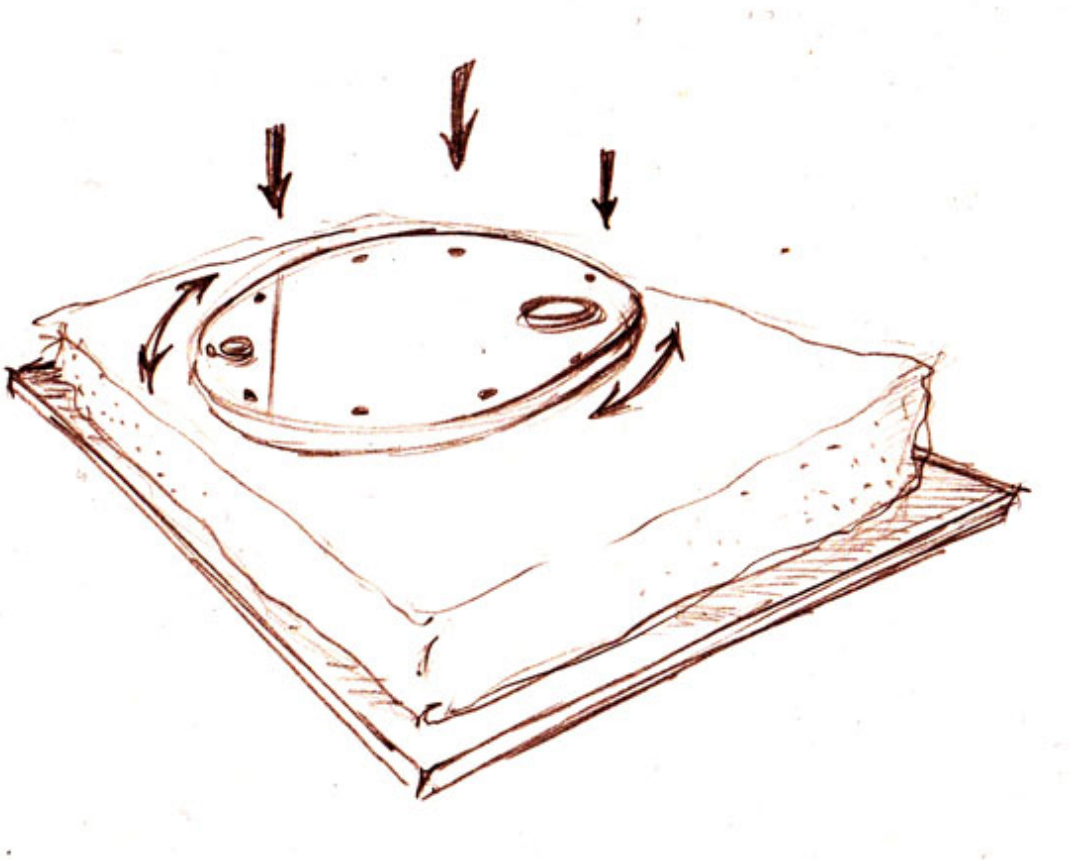


Step 5: Using a drill size to match the through bolts you are going to use (we usually drill 6.5mm to take a 6mm bolt) drill at all the marked points.

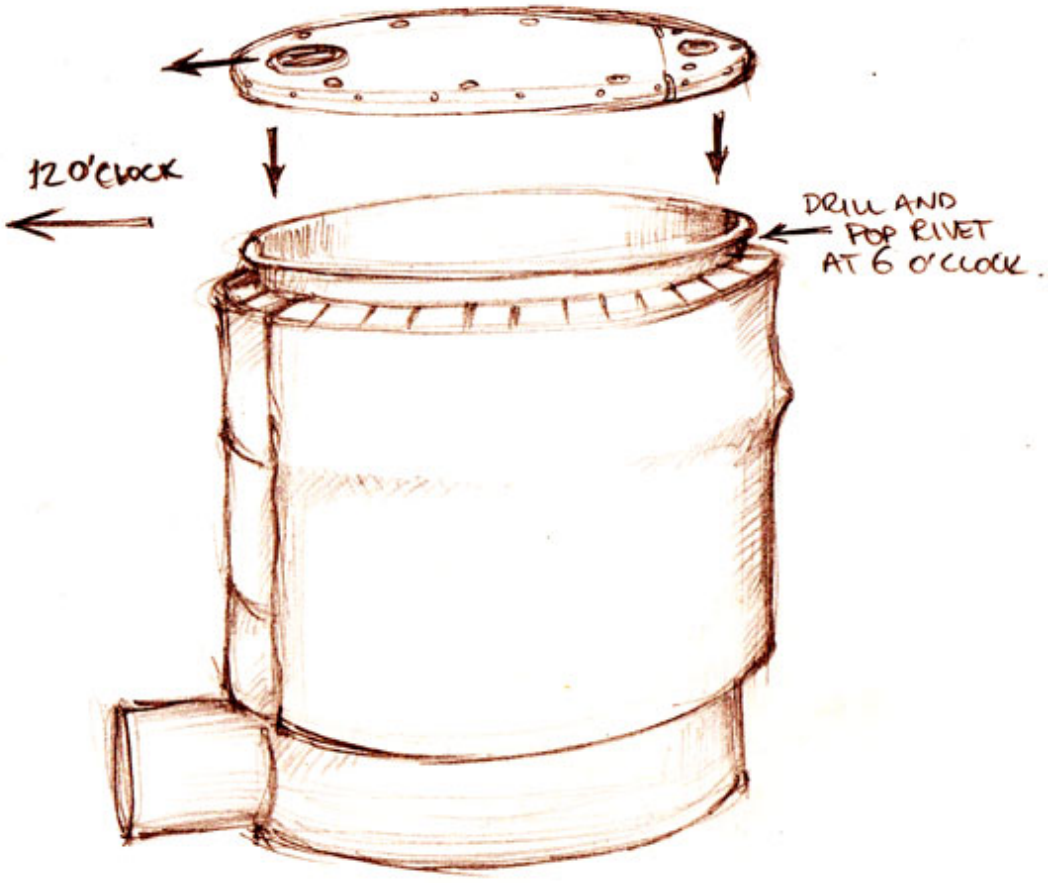


Step 6: Lay the outer lid you have just drilled lip down over the inner door lid you reserved earlier (the one without bungs). It should sit nice and snug. Keeping your drill at 90 degrees to the surface, and using the already drilled holes as a guide, drill a hole at the first position above the 110mm line – either end, it doesn't matter. Put your first through-bolt through the two lids and nip it up a little bit more than finger tight. Next drill the first hole above the other end of the 110 line and nip up with a bolt. Next, drill out all the holes and fit bolts as each hole is drilled. This way we are making sure the holes in the lid will line up accurately. Once all the holes are drilled, remove all the bolts so the door is in two pieces again.

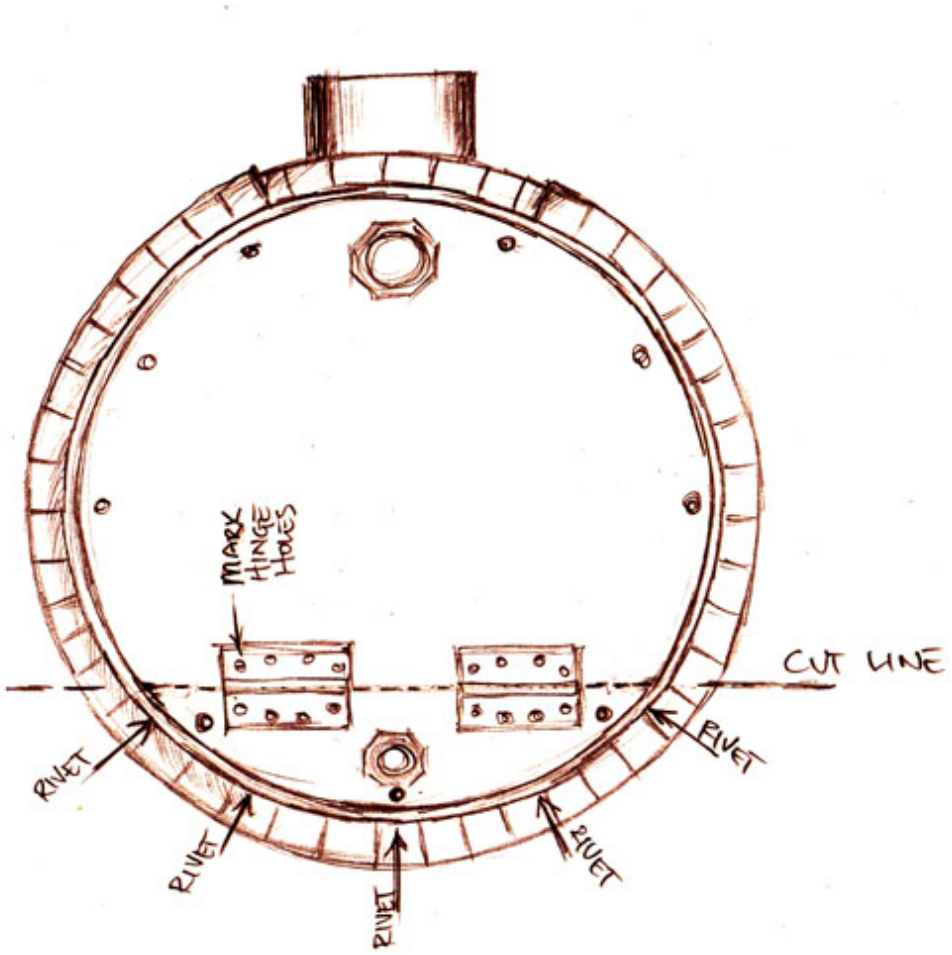
Step 7: Lay a piece of fibreglass insulation on a flat surface and position the outer door on top lip down. Using it like a cookie cutter twist while pushing down to cut out a circular biscuit of insulation. The insulation may be too thick to be easily compressed between the two lids so ‘peel’ the biscuit until it is approximately 25mm to 30mm thick uncompressed. With the insulation in place, reassemble the door with bolts and nip up lightly. You may have to poke a sharp bit of wire through the insulation to allow the bolts through. The reason we do it this way is that if we assembled the door with the insulation in place and then drilled there is a tendency for the insulation to wind around the drill bit which is a pain, but more importantly it makes big gaps in the insulation layer.



Step 8: Now, grab your mostly-assembled oven barrels, and keeping the big bung in the lid aligned with 12 o’clock and facing outwards, push the door assembly into the end of the inner barrel. Push in until the lip of the inner door lid is level with the end of the barrel.

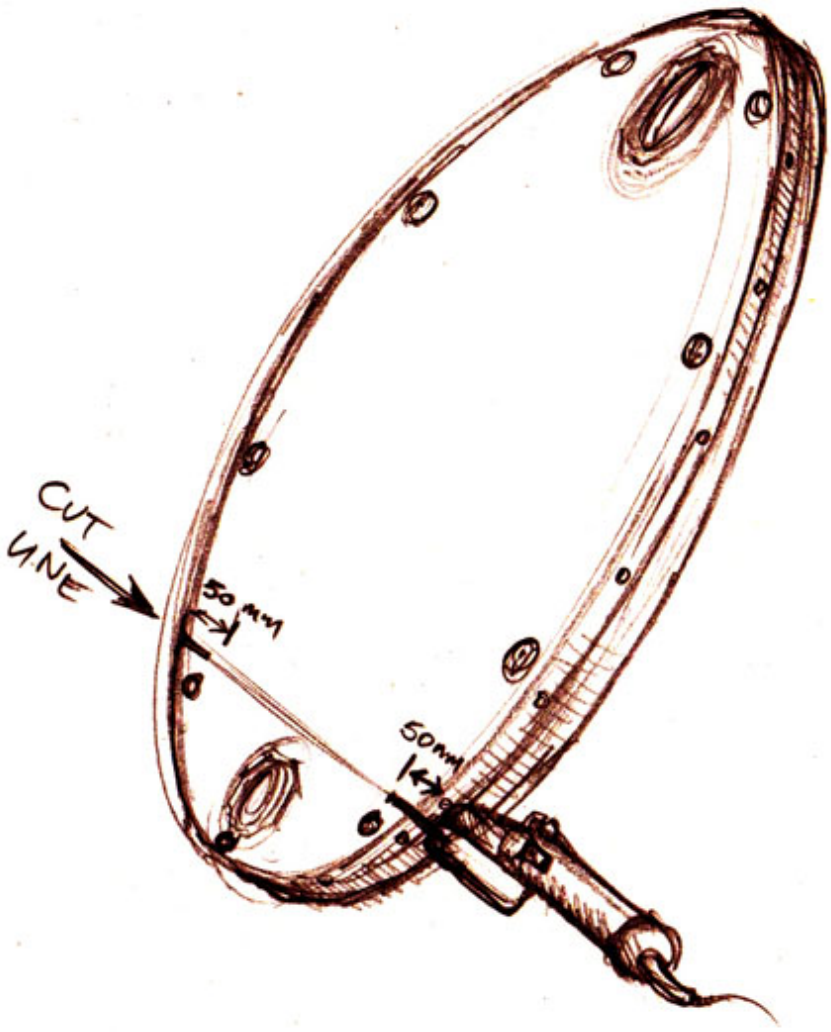


Step 9: Now fit your drill with the correct bit to suit your pop rivets and drill a hole through the inner barrel, with the lid and the hoop underneath at the 6 o'clock position. Put a pop rivet in place making sure the shank is long enough to pass through all three layers but **do not pop rivet in place yet**! This is to stop the lid moving as you drill the remaining holes. At half the remaining distance to the 110mm line, drill two more holes and put pop rivets in place, but again do not rivet in place. And then just below the 110mm line drill one more hole each side and again **do not rivet**.



Step 10: Remove the door from the oven and position your two door hinges so the pivot point is directly over the 110mm line. Mark the hinge bolt holes, but don't drill at this stage.

Step 11: Grab your angle grinder with a cut-off disc installed and cut through the two bolted together lids at each end of the 110mm line. Cut in as far as you grider will allow. Cut all the way along the 110mm line on the outside of the door and then on the back side of the door draw a line between the two cut marks and cut that line out to give you two separate door pieces. Don't worry, the insulation will not wrap around the grinder blade as it tends to cut the fine threads rather than twist them together like a drill will.

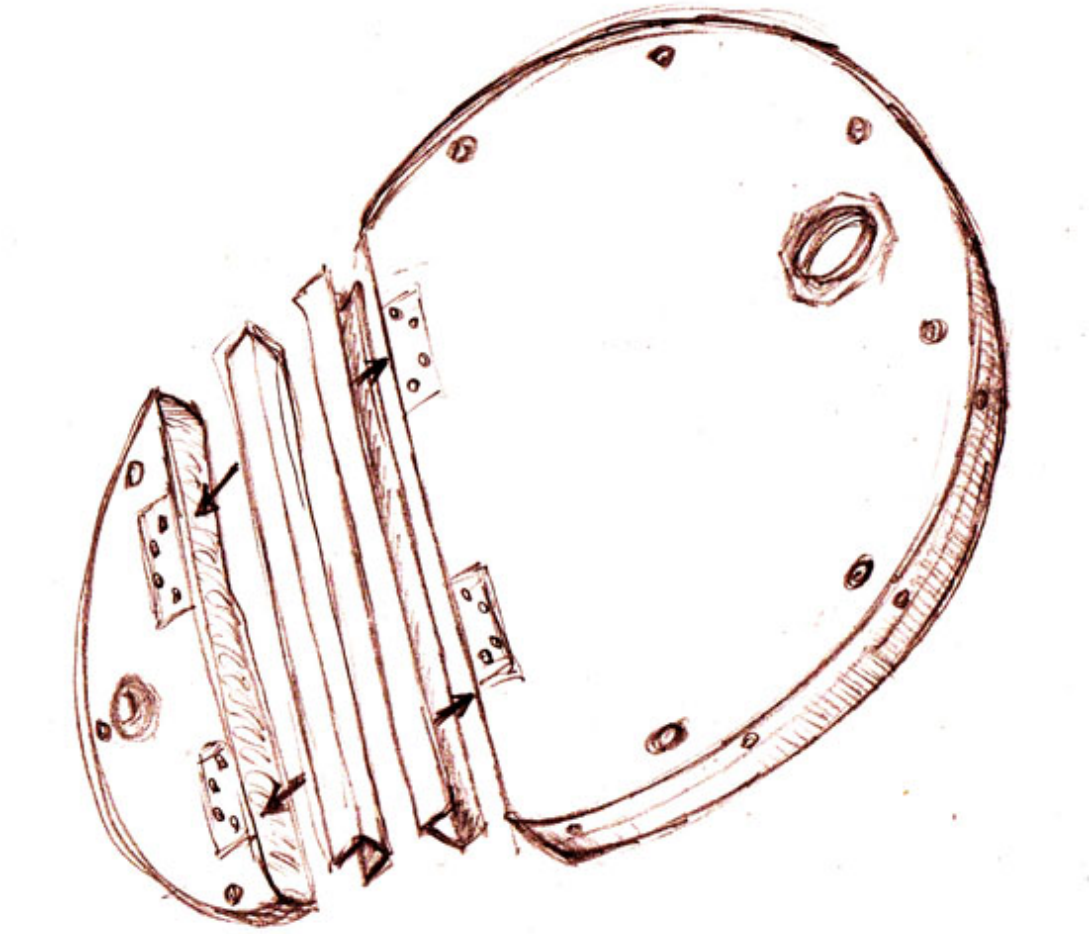


Step 12: You can now drill the holes to mount the the hinges, but first push the insulation away from where you are drilling to avoid the insulation wrapping around the drill bit.

Step 13: Okay, so we could bolt the door hinges on now and call the door finished but the bottom edge of the door along the 110mm cut line tends to be unstable and insulation is exposed. To strengthen this area and cover the insulation it's best to insert a spacer between the inner and outer skins on the top and bottom sections of the door.

We are looking at something with 'C' channel or square section that will fit neatly between the two door skins. While there are a few possibilities, the angle sections that you use for you shelf supports are very close to perfect.

All you have to do is slide two sections that are the correct length together to get the correct width and then drill and pop rivet. These can then be slid between the door skins and then drilled and bolted in place using the hinge mounting bolts and or pop rivets or a combination of both.



Step 14: Put the lower section of the door back in place at the 6 o'clock mark and pop rivet in place using the previously drilled holes.

Step 15: Mount the hinges to the lower section of the door and then lift the upper section into place and bolt up. Test the fit. The door should fit pretty well as it has been made in place but a little flexing and tweaking may be required.

Congratulations! Apart from the latch, that's the door done.

Building the door latch

Basically we are going to use the large bung as a pivot for a door latch. A piece of wood will be bolted to the bung as the handle with a flat piece of scrap drum sandwiched between. The bung is then wound most of the way into the bung hole in the outer door skin. The flat piece of scrap drum will project past the edge of the drum lid. When we then shut the lid and pivot the handle clockwise, the flat metal will sweep sideways and engage in a notch in another shorter piece of scrap riveted or bolted to the outside of the inner drum and bent so it runs parallel to the drum.

Following the instructions will give you a simple neat door latch but you can also get a little fancy and substitute any number of objects for the wooden handle. One of Joel's favorites is old pointed trowels with the tip of the trowel acting as the latch, and I have even seen him use the handle off a coffee machine. Driftwood and deer horn are other examples of materials used.

A word too about temperature gauges. You can easily install a barbeque style temp gauge into the door of the oven just drill a suitable hole in the outer skin and mount it up. Just make sure the probe part is long enough to project at least a little through the inner door skin. These gauges can be bought on line or scrounged out of old bbq's just make sure they have a range up to approx 500c or you will likely kill them with the temperature these ovens can achieve cooking pizza. My best effort to date was 517°C without trying too hard.

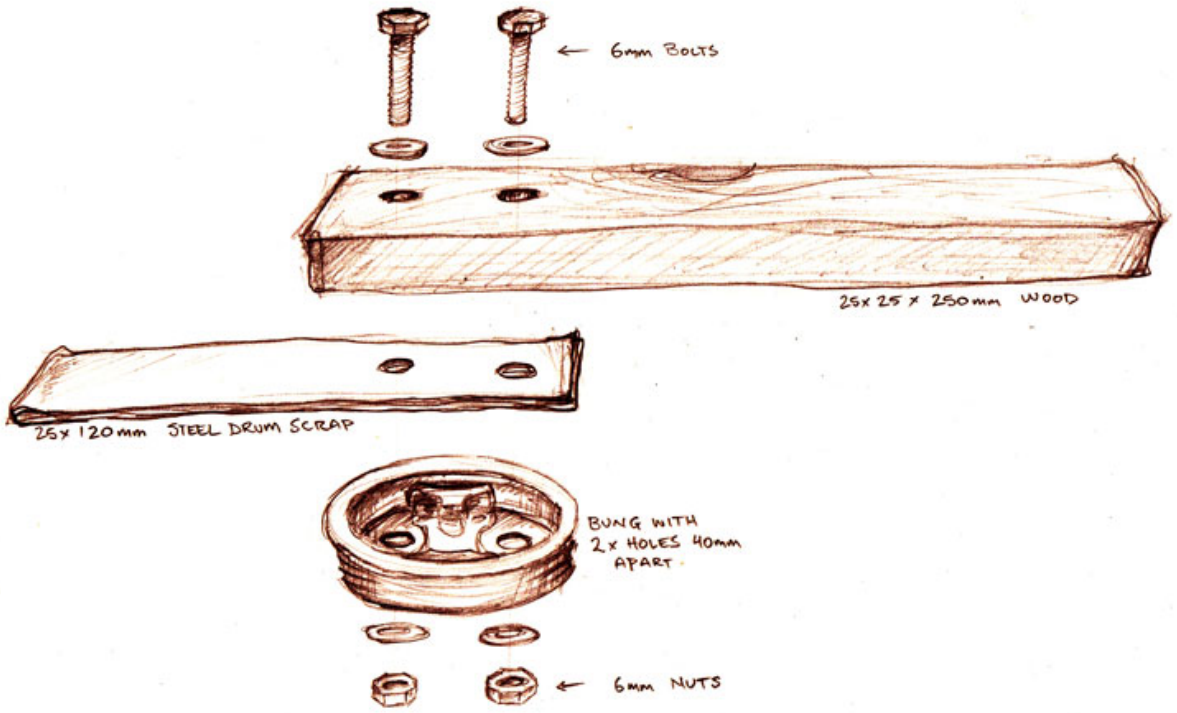
Step 1: Drill two 6mm holes 40mm apart in the large bung. Remove the rubber 'o' ring.

Step 2: Find a wood off-cut 200mm long and approx 25mm square for your handle. Lay the bung on your chosen handle so it is across the full width of the bung and, using the two holes in the bung as a guide, drill through the handle.

Step 3: Cut a piece of flat scrap drum 25mm wide x 240mm long, and then bend it back on itself so it is 25mm x 120mm long. Lay the bung on top of the end of the steel, without the bend so the steel spans the full width of the

bung and using the holes in the bung as a guide, drill two holes in the flat steel.

Step 4: Put two bolts through the holes in the wood and then slide the flat steel over the bolts, so the steel projects out past the wood, then slide the bung (dished face first as it won't wind in the other way) over the bolts. Put nuts on the bolts and tighten then wind the bung nearly all the way into the bung hole.



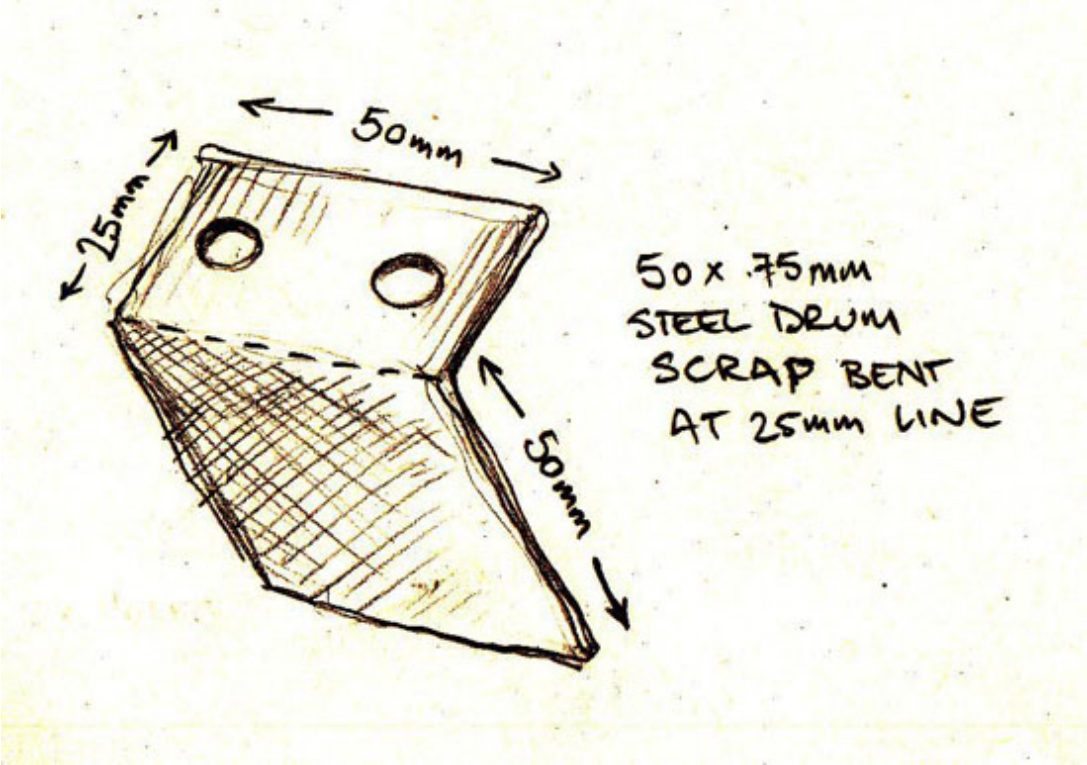
The various pieces for the door handle. Of course you can get creative and sand, carve or paint the wooden handle.

Step 5: Push the door shut and position the handle vertically. The end of the flat metal strap should project past the lip of the drum. Mark the position of the left hand side of the strap on the lip of the drum.

Step 6: Cut a flat piece of scrap 50mm wide x 70mm long and mark a line 25mm in and parallel to the 50mm edge and bend to 90 degrees at the mark. You should end up with an 'L' shaped piece of steel.

Step 7: Drill two holes in the foot of the L and then sit the L against the outside of the inner barrel hard up against the rolled lip with the foot of the L

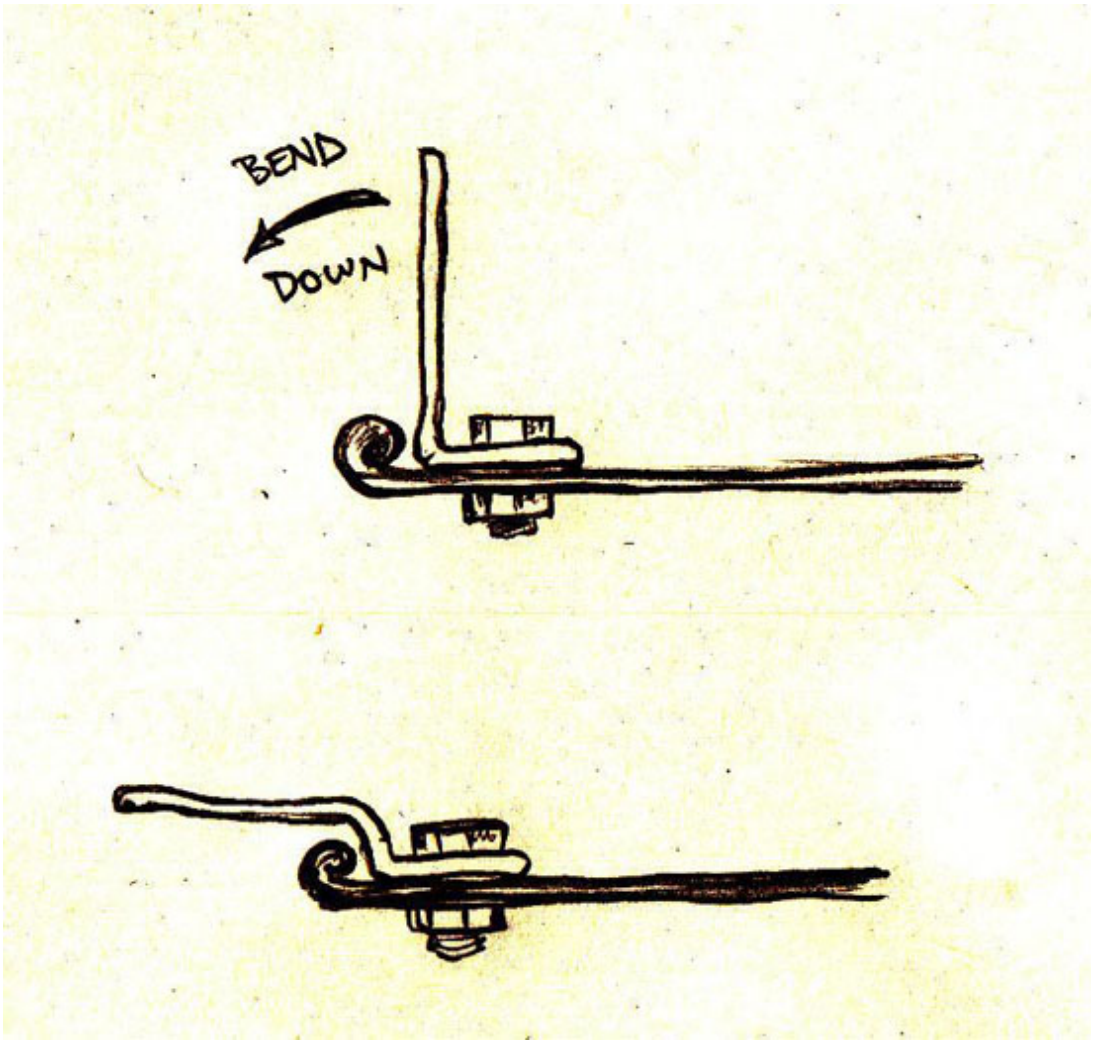
facing towards the back of the oven. Make sure the left hand edge of the L is lined up with the mark you made in step 5 and then mark and drill the two holes using the holes in the L as a guide.



The latching tab which bolts to the outer barrel.

Step 8: Put bolts through the holes and tighten in place.

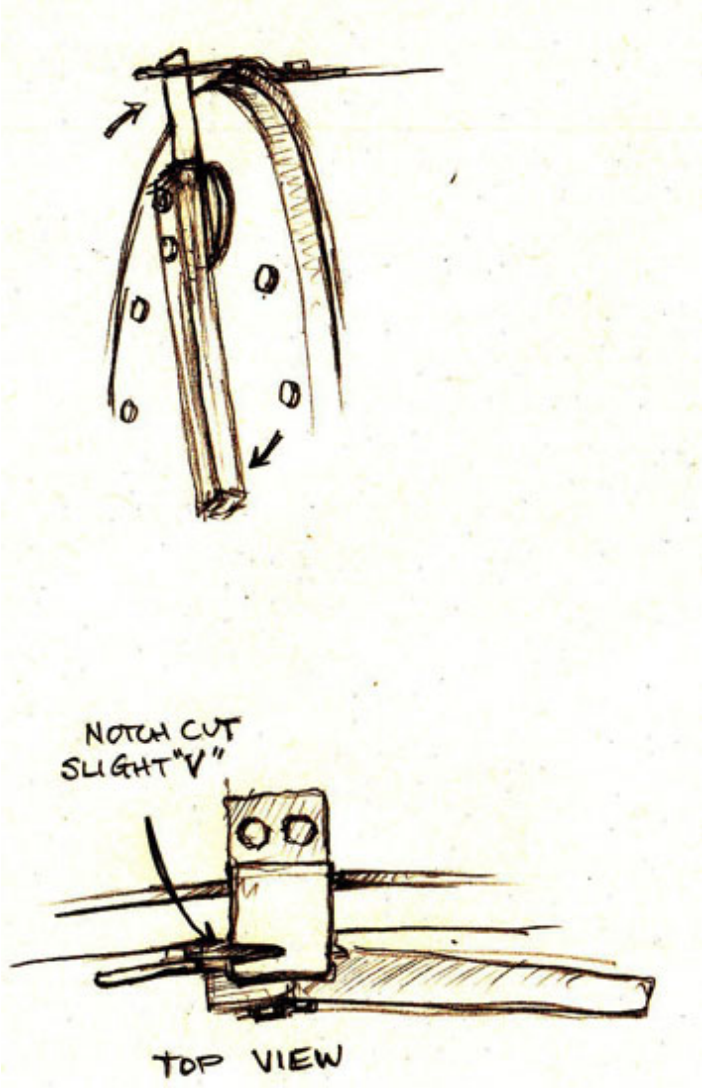
Step 9: Bend the long leg of the L forward and parallel to the drum.



The latching tab bent into final position.

Step 10: Make sure the oven door is snugly closed and then swing the handle clockwise so the metal strap on the edge of the handle contacts the side of the now bent L on the drum. Mark this point.

Step 11: Notch in 25mm at this point and make the cut slightly V shaped at the opening so it is easier to line up the strap on the handle with the notch.



That’s it! Door done.

You might think we have pretty much finished the oven build and you would be right, but we are also at the point with the most variables and the most generic information and that is the building of the stand and insulating the oven. With that in mind, read the following two sections well and work out your plan of attack before starting. We have given general instructions which will give you a nice functional oven, but remember there are lots of different materials and ways to build your stand and these will have an effect on your outer insulation layer.

The stand

When constructing the stand a lot will depend on how permanent you consider the installation to be and the look you are trying to achieve not to mention the materials and skill sets you have access to.

Some basic principles apply regardless.

Support from the sides

The one way to support the oven in a permanent installation is to ‘cradle’ it parallel to the sides

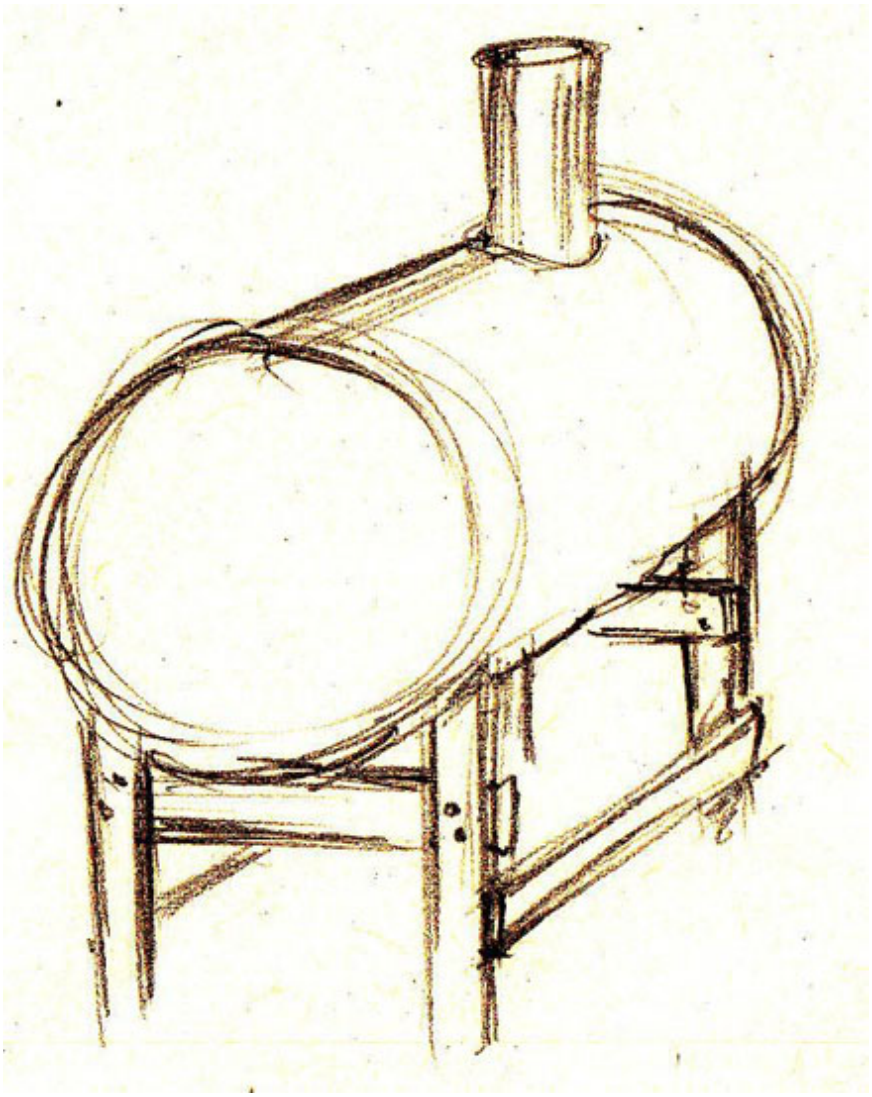
To work out the distance to set the cradle arms or opening measure across the front of the oven including the outer cover in line with the bottom edge of the door where it pivots. The distance between the sides of the cradle have to be slightly smaller than this as, if it is larger, the oven will sit into the cradle deeper than the door pivot and you will not be able to get the door open. Remember too that the cover will compress a little as it has a layer of glass wool underneath it. You can ignore the above if you don’t plan to have

a front rail on the frame, but too far apart on the rails and the oven will want to squeeze between the rails.

The main disadvantage of this method is it means it will be a bit more difficult to accurately set the height of the bottom of the oven in relation to the rocket stove. Having said that, this is how I normally do it because I like the look.

Support from below

The other option is to support the oven from the bottom. In this installation the rails that support the oven run under the front and the back of the oven respectively. One advantage of this setup is that the rails accurately set the height of the bottom outer skin of the oven which means you can accurately build the rocket stove to the correct height or reversing this, accurately build the frame to suit the rocket stove.



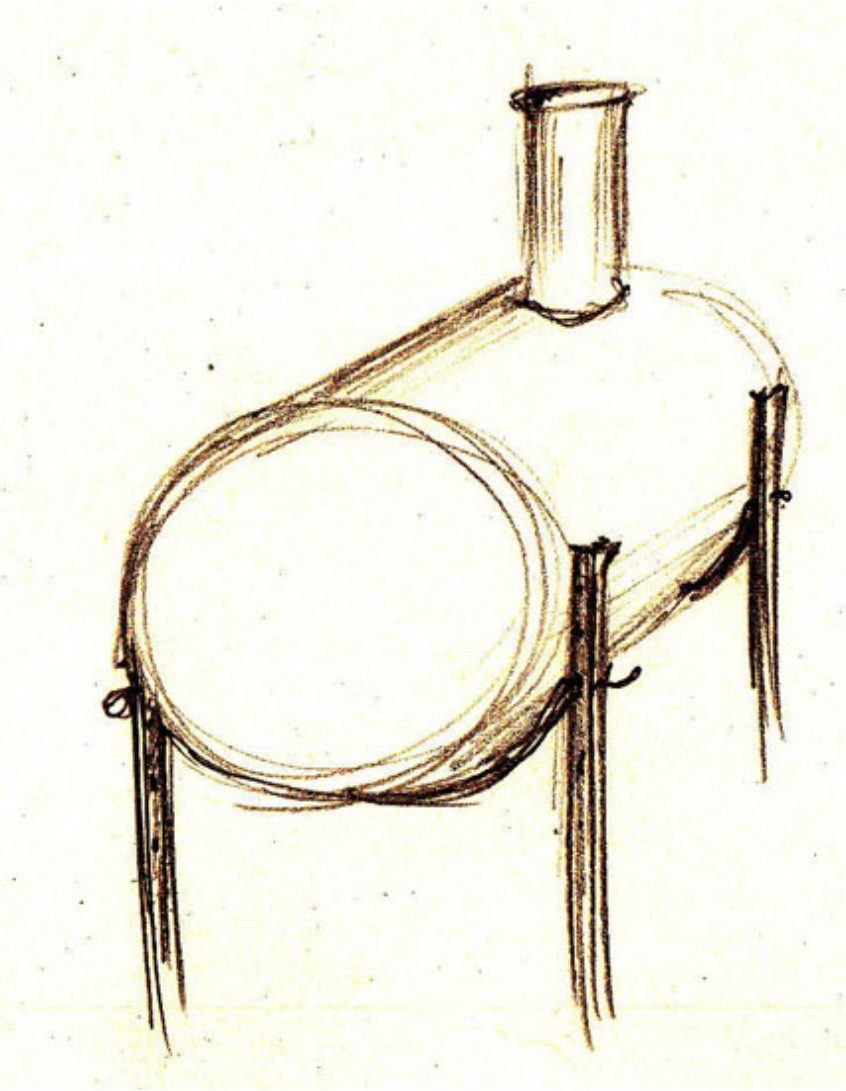
There is an even easier way to support the oven which is very robust but is a bit rougher and would be used for a quick installation. It is also only suitable if you are installing over soil, not concrete or other hard surface. Yes, we're talking star pickets. Here's how to do that:

Step 1: Measure across the oven at its widest point and then mark two parallel lines on the ground that distance apart. Measure from the front to the back of the oven take 100mm off this measurement and then mark this measurement on your parallel lines making sure all is square.

Step 2: Drive a star picket ('waratah' to some) into the ground at each point trying to keep the pickets vertical and parallel as possible and to the same height.

Step 3: Loop some fencing wire between the two front pickets and then between the two rear pickets. Guesstimate where on the picket you will attach the wire to achieve a good working height for the oven.

Step 4: Pick up the oven and sit onto the wires between the pickets. The wires will bend to follow the curve of the oven and pull the pickets against the sides of the oven holding it tight.



Insulating and covering the oven

To work efficiently the oven will need to be insulated. I have always done this with rockwool or fibreglass batts, as they are cheap and easy to get hold

of. Get batts made for walls, as they are usually 75-90mm thick, which means they usually squeeze down to around 50mm thick which is perfect for our needs.

As these ovens are for outdoor use I usually cover them in old sheets of corrugated iron. It protects the oven from the weather looks great and the iron follows the curve of the barrels well. Plus, it’s cheap.

Just to clarify, when we talk about length with roofing iron we are referring to the distance measured running parallel to the corrugations. I have kept that convention here even though the piece of iron we will end up with will be wider than it is long.

The process laid out in the following steps will give you a well-insulated oven, but it is not the only way to insulate the oven. Read carefully first and then consider your options. Joel tends to build his stand and then attach the bottom outer corrugated sheet to the stand, place the insulation and then lay the oven on top, and then bring the remaining sheets of iron and insulation over the top.

Step 1: Measure the width of iron needed to totally wrap around the oven and then add a generous amount more as we have to allow for a layer of insulation and some overlap of each sheet. Normally 4 sheet widths will do it.

Step 2: Work out the length needed. This should be the total length of your oven plus 200mm. This gives us a cover with a 100mm lip at the front and 100mm at the rear. The rear space will allow us to install some insulation and a tin cover while the front protects against rain. On the front I usually taper from 100mm at the top to level at the bottom as it looks good and is practical but for now just cut your sheets 200mm longer than the total length of the oven.

Step 3: We are going to cut the opening for the heat riser of your rocket stove in the bottom sheet. The dimensions and shape of this hole will depend entirely on how you have constructed your rocket stove but regardless the instructions remain the same.

Take one sheet of the iron you have already cut and mark a line down the centre of the sheet. Measure 330mm from one end and mark. This gives us the centre of the opening.

Step 4: Mark the outside dimension of the heat riser on the sheet centred around the mark you made at 330mm and cut out.

Step 5: Lay the sheet on the ground and then lay one sheet either side with one corrugation overlap. As we move outwards from the sheet with the hole cut in it overlap on top of the next sheet. This is so as water runs down the iron on the outside so it sheds water off the overlap not funnels it in behind the iron wetting the insulation.

Step 6: Screw 4-5 metal screws along each overlap and the flip sheet over.

Step 7: Lay out some fibreglass insulation over these sheets. Overlap any joints so there are no gaps, but on what will be the door-end, set the insulation 100mm back from the edge of the iron

Step 8: Place your oven on top of the iron sheet with the opening in the bottom centred over the opening in the iron. This will sandwich the fibreglass in place.

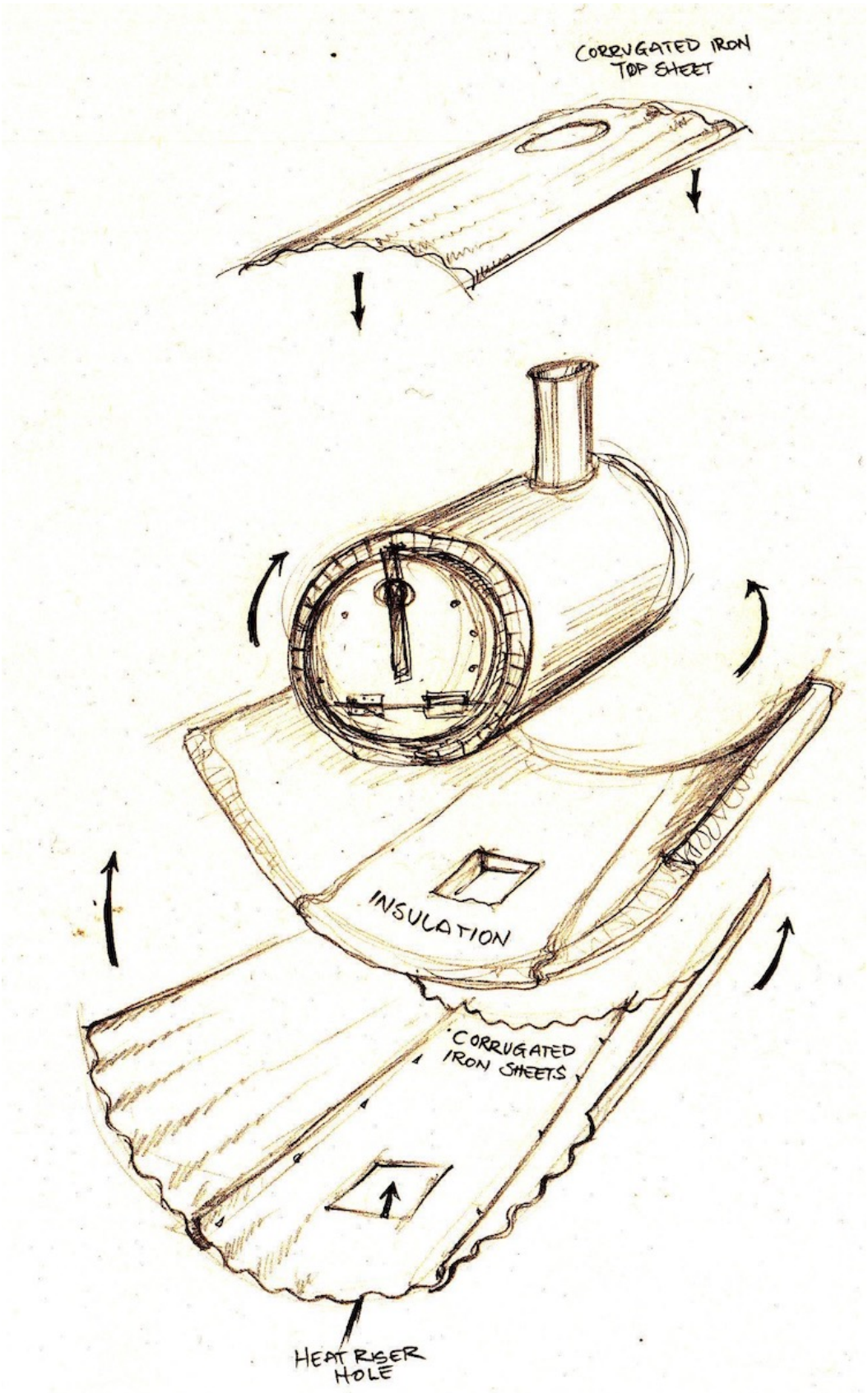
Step 9: Wrap the iron and insulation sandwich up and over the oven and make sure that the insulation goes all the way over the top of the oven and either tuck it around the flue pipe or cut a hole in the insulation and lower it into place. Remember: no gaps.

Step 10: Wrap some string around the whole assembly pull tight and tie so that everything is held in place.

Step 11: At the back of the oven lay a straightedge across the ends of the sheets adjacent to the gap at the top and measure back to the flue pipe. Take your final sheet of iron, mark the centre line and then mark the distance you measured back to the flue on the centre line.

Step 12: Remembering this is the outer edge of the flue, not the centre, mark and cut the flue hole in the iron sheet.

Step 13: Lower the final sheet into place over the flue pipe and then screw in place, and cut and pull out string.


CORRUGATED IRON
TOP SHEET
INSULATION
CORRUGATED
IRON SHEETS
HEAT RISER
HOLE

Step 14:

Lay one of your corrugated iron off cuts across the opening in the back of the oven mark with a pen and cut out.

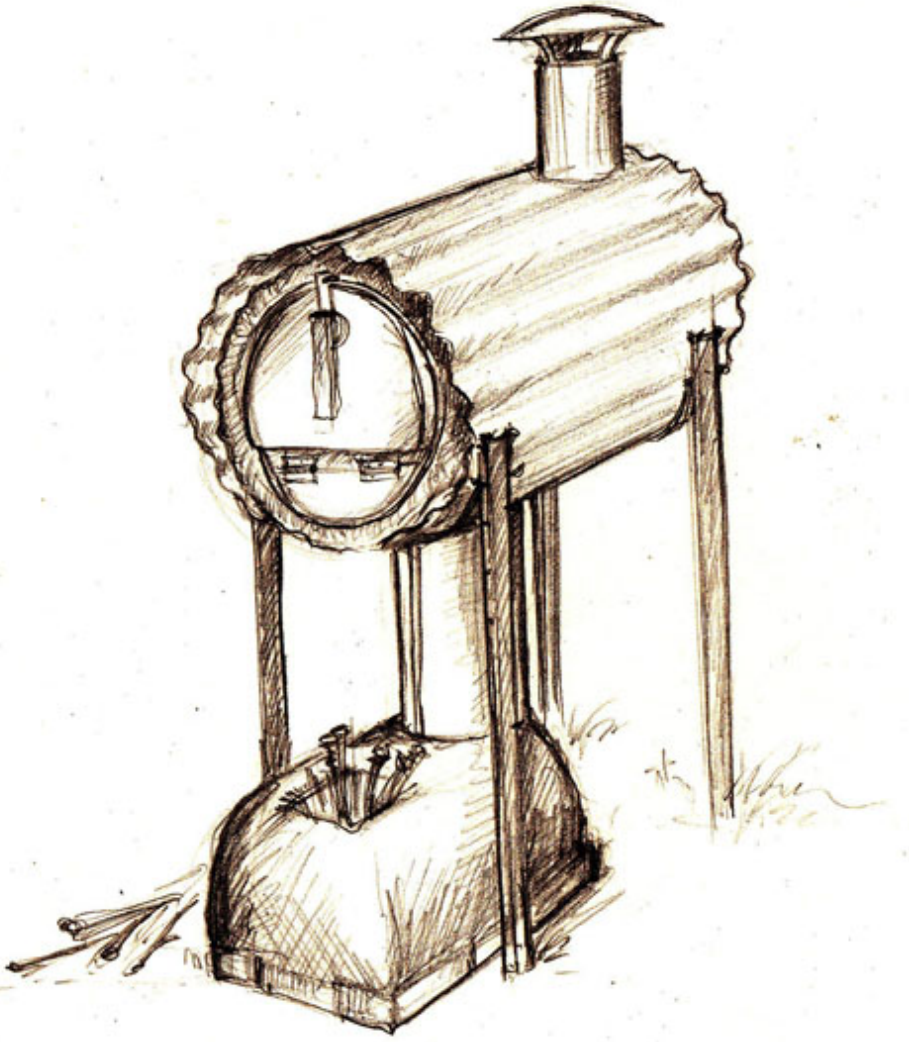
Step 15: Lay the cut out on top of a fibreglass batt and cut out about 25mm bigger.

Step 16: Push the fibreglass piece against the back wall of the oven and push the cutout sheet of corrugated iron up against and screw 4-5 metal screws in from outside to trap the iron behind them.

Step 17: The oven is capable of living outdoors but if the stove won't be under cover make sure you run a good bead of silicon around where the flue passes through the corrugated iron cover, or water will travel directly into the outer barrel. You will also need to add a rain cap.

Final touches

The final act is to block off possible small gas leaks between the tabs at the front of the oven. This can be done a few ways but by far the easiest is to make a sticky mix of cob (3-4 parts sand to one of clay) and smear and smooth it into the gap between the inner barrel and the outer skin. The lip of the inner barrel will hold the cob in place and the earth mix makes a nice touch. Smooth stones, sea shells or other objects can be bedded in the mix for looks.



Controlling the beast, or how to cook with your oven.

Not surprisingly temperature control seems to be the one thing that everybody is concerned about when cooking with a wood-fired oven. What is surprising is that is that it never seems to become the issue everybody thinks it will be. I would advise strongly to get hold of an infrared thermometer, these can be had for under $40 at most car parts stores or online, the temp range of the cheap ones goes up to around 580°C which is more than enough for your needs. With this you can begin to become familiar the effect various temperature manipulation methods have on your stove and what are the hot and cool spots. You can also buy small ‘in-oven’ thermometers that can sit on or hang from the shelves, and the ultimate – because you don’t have to open the door – is a barbecue thermometer that you can install in your door. Just make sure that the probe makes it all the way into the cooking chamber and mount about halfway up the door to give an indication of the average temperature. If you get really excited, you can cut an opening in the outer door skin slightly bigger than the body of the thermometer and flush mount it.

As I talked about earlier, these ovens are easily capable of temperatures exceeding 400°C, so how do we cook and not burn everything to a crisp?

Well, we can manipulate a number of factors to control temperature.

Fuel load

As discussed earlier lots of small sticks will give lots of heat as we are increasing the surface area of the fuel exposed to air. So if we want to cook authentic pizza we use lots of smaller diameter fuel. Be aware too that the density of the wood will make a difference. In Australia we have access to beautiful hardwoods that contain more energy for a given volume of wood that softer lighter woods like the pine that most in the US would be used to. So a bundle of thinner hardwood sticks will give the hottest possible fire. Of course it will also be the fire you have to be the most attentive to, checking

the fuel every 10 minutes or so. Luckily, we very rarely cook at these temperatures, and when we do it’s foods that are pretty hands on like pizza.

Over 90% of the foods we would cook in an oven require a temperature of around 180°C and these can be achieved in a very relaxed manner. Experience has shown that 3 sticks of around 50-60mm will cruise at around 180°C and take up to 40-45 minutes before needing replacement. A hot rocket will happily burn three sticks but you will find dropping below this number will see the fire eventually go out.

So between lots of little sticks and three big sticks there is a combination for every recipe.

Air

Up to a point, lots of air is good, but there are a few things we have to be aware of. The first is that any air in excess of what the fuel needs to burn properly is just cooling the fire. So a very hot fire with lots of small fuel tends to need the maximum amount of air while our three thicker sticks which are exposing less fuel to the fire require less air. We can manipulate the air easily by partly closing the feed tube off for slower cooler fires. My high-tech approach is a brick or a piece of tile that I can partly sit over the feed tube opening.

Time

Prior to the advent of electric or gas ovens most recipes called for a “fast”, “moderate” or “slow” oven. This was because a lot of the old wood stoves had no temperature gauges and so our temperature settings fell into the educated guess category instead of infinite, precise thermostatically-controlled temperatures. And yet delicious food got cooked. So keep an eye on the food; if it starting to brown too much, take it out. A word of caution though. Very thick or massy foods like roasts can be both burnt to a crisp on the outside and cold on the inside if we apply too much heat too fast so it’s better with these sorts of foods to cook in a “moderate” oven and then pump up the volume at the end to brown off. They are not used much these days but a meat thermometer is a great tool for cooking roasts and such, especially in a wood oven.

Position

Just as in real estate, think ‘position, position, position’. Food at the bottom will tend to cook more on the bottom, food at the top will cook more at the top. Having a big tray of veggies above a roast will slow the cooking of the top of the roast. Reverse the position and the veggies will cook before the roast is done and the roast will be slower cooked on the bottom. Again, get involved, monitor the food and swap around. Remember: this is supposed to be a dance.

Mass

Food is mass so an oven jam packed with food will cook all the food slower. Pump up the volume and shift the food around.

We can also use other mass to slow down temperature swings and get an oven that, while a little slower to reach temperature, will be easier to cook in.

Clean sand poured into the bottom of the oven works well as does clay tiles, broken brick or other massy non combustible or off gassing materials. For my oven at home I lined the bottom with some fire bricks ‘splits’ which are basically a very dense, half thickness brick.

Just remember that the more mass you add, the slower the oven will heat so don’t add too much straight up.

Taking care of your beast

The oven

The outer barrel of your oven will last indefinitely but the combination of temperature, oxygen, and moisture will rust your inner cooking barrel out in two or three years of continuous use if you don’t follow a few simple rules.

1. After you’ve finished cooking leave the oven door open till the oven is cool. This will allow any moisture that has accumulated from the cooking of the food to evaporate.

2. Oil the inner barrel on a regular basis just like you would a cast iron pan. Vegetable oil of course.

The rocket stove

Clean the ash out occasionally. You don’t have to do it daily or even weekly, but the stove will work better if you don’t choke it to death on ash. It may look fine at the bottom of the feed tube and the burn tunnel, but it accumulates in the 90 degree turn at the base of the heat riser. The human hand is about the best tool I have found for cleaning the accumulated ash out. Just make sure that the oven is cold before attempting, and a pair of gloves wouldn't go astray as often when using old off cuts of wood you may find nails in the ash layer. Ash is a great insulator so just get most of it out; it doesn’t have to be spotless.

Tips and tricks

Like smoked food? Put some wood suitable for smoking into a couple of food tins that nest inside of each other and that have been thoroughly ‘burnt’ in a fire to remove any residues from the coatings applied to the inside. Punch a few small holes in the outer tin and lay the tins on their side in the bottom of the oven and you're in business. You can also just wrap your smoking chips inside some alfoil with a few holes in it. Don’t be tempted to put wood into the bottom of the oven, while it will smoke beautifully the instant you open the oven door and let air in you have completed your fire triangle and may get a fireball racing out to greet you. The foil and the tins limit the air that can get to the smoking wood so you won’t have any flames.

Don’t have any wood for smoking? Try some tea leaves which make a beautiful smoke flavour; my favourite when hot smoking fish in the oven.

Cooking pizza? Having a good pizza stone or a layer of firebrick splits or clay tiles to cook on will have you turning out pizza like the pros. Just remember to preheat.

I spoke at the start of this booklet about the implications of the word ‘convenience’. These stoves aren’t as convenient as modern stoves. They

require a level of understanding and observation and finally of mastery to get the best out of them. Now, that doesn't mean you can't start turning out delicious food immediately. But with practice, their use becomes a beautiful creative dance. Happy dancing.

Tim Barker

Learn more!

VEG appropriate technology workshops

Very Edible Gardens (VEG) is a Melbourne, Australia based permaculture design consultancy who also run workshops (such as the two week Permaculture Design Certificate, which includes a trip to your illustrator Joel Meadow's wonderful passive solar, rocket-powered home). In 2015, Adam and Dan from VEG decided we wanted to help increase Joel and Tim's profiles, as they are a formidable duo with skills and passion that demands wider exposure. So we worked with them to create the AppropriateTechnology.com.au website with instructionals, and details of upcoming appropriate technology workshops – which of course includes rocket stoves, but also natural building, biochar, scything, humanure and, in the future, much more. We'd love to see you at one of the workshops! Thanks for making it to the end of the booklet. If you have feedback on the

booklet or your own experience, please let us know via the contact form at AppropriateTechnology.com.au.